PROJECT NO.NSD16949

FINAL DRAFT REPORT TO

NOVA SCOTIA DEPARTMENT OF
TRANSPORTATION AND PUBLIC WORKS

ON

ENVIRONMENTAL ASSESSMENT
HIGHWAY 104 ANTIGONISH

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in association with

Atlantic Road & Traffic Management,
&
Hydro-Com Technologies Ltd.,

April 2005

105-05601/

EXECUTIVE SUMMARY

Nova Scotia Department of Transportation and Public Works (NSTPW) proposes to construct and operate a 15 kilometre fully controlled access, four-lane divided highway from Addington Forks Road, west of the Town of Antigonish, to Taylor Road, east of the community of South River, Nova Scotia (the Project). Highway 104 is part of the National Highway System and is therefore eligible to be cost shared by the Federal and Provincial governments. Eligibility for federal funding is dependent upon approval of the proposed Project under the *Canadian Environmental Assessment Act*. As the Project is over 10 km in length, it also requires approval as a Class II Undertaking pursuant to the *Environmental Assessment Regulations* under the Nova Scotia *Environment Act*.

NSTPW has conducted a preliminary environmental screening, public consultation and a functional analysis of the proposed alignment as part of the preliminary planning for the Project. The Project has also undergone a detailed safety review, an independent peer review and a detailed assessment of environmental impacts at the South River crossing. These studies resulted in the selection of alignment options.

The assessment of the selected alignment considers biophysical and socioeconomic issues, focussing on issues of greatest concern known as Valued Environmental Components (VECs) and Valued Socioeconomic Components (VSCs) identified through a scoping process including consideration of the NSTPW Terms of Reference. Each of the following eight VECs and four VSCs selected for this assessment were evaluated for potential Project related effects:

VECs

- Atmospheric Resources
- Groundwater Resources
- Fish and Fish Habitat
- Rare Herpetiles
- Rare Mammals and Critical Habitat
- Rare and Sensitive Birds
- Rare Plants and Plant Communities
- Wetlands

VSCs

- Local Economy
- Land Use
- Archaeological and Heritage Resources
- Transportation Infrastructure

Mitigation and monitoring have been proposed to reduce or eliminate potentially adverse effects. The significance of residual environmental effects (*i.e.*, after mitigation has been applied) including cumulative effects was predicted for each VEC/VSC. In general, potential adverse effects on these VECs/VSCs will be short term and/or highly localized and can be effectively mitigated through technically and economically feasible methods recommended in this report. Potentially adverse residual effects are therefore predicted to be not significant for all VECs and VSCs.

Operation of the Project will provide safe, convenient, economic and efficient movement of persons and goods through the area, thereby having a positive effect on transportation infrastructure. Decreased traffic along the most existing uncontrolled access Highway 104 will contribute to a quieter, safer living environment for most residents.

In summary, this Project will provide a long term public benefit by reducing current traffic volumes on the existing uncontrolled access portion of Highway 104. It will also provide infrastructure to handle future traffic volumes and patterns, thereby improving public safety, without significant adverse environmental effects.

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LIST OF ACRONYMS

AADT	Average Annual Daily Traffic
ACCDC	Atlantic Canada Conservation Data Centre
AEC	Atlantic Expressway Committee
ARDA	Antigonish Regional Development Authority
CEA Agency	Canadian Environmental Assessment Agency
CEAA	*Canadian Environmental Assessment Act*
CEPA	*Canadian Environmental Protection Act*
CLC	Community Liaison Committee
CMA	Calcium Magnesium Acetate
CO	Carbon Monoxide
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DFO	Department of Fisheries and Oceans Canada
EA	Environmental Assessment
ECM	Environmental Compliance Monitoring
EEM	Environmental Effects Monitoring
EPP	Environmental Protection Plan
FCR	*Federal Coordination Regulations*
FHWA	Federal Highway Administration
FWAL	Freshwater Aquatic Life (Guidelines)
HADD	Harmful Alteration, Disruption or Destruction
HMVK	Hundred Million Vehicle Kilometres
H_2S	Hydrogen Sulphide
IT	Information Technology
JW	Jacques Whitford
JWEL	Jacques Whitford Environment Limited (pre 2004)
NEB	National Energy Board
NO_x	Nitrous Oxides
NO_2	Nitrogen Dioxide
NSDAF	Nova Scotia Department of Agriculture and Fisheries
NSDEL	Nova Scotia Department of Environment and Labour
NSDNR	Nova Scotia Department of Natural Resources
NSDOE	Nova Scotia Department of Environment
NSDOTC	Nova Scotia Department of Transportation and Communications
NSPI	Nova Scotia Power Inc.
NSTPW	Nova Scotia Department of Transportation and Public Works
O_3	Ozone
PDO	Property Damage Only

POLs	Petroleum, Oils, or Lubricants
RA	Responsible Authority
Rcap-MS	Rapid Chemical Analysis Package-Metals Scan
RoW	Right of Way
RWIS	Road Weather Information System
SARA	*Species at Risk Act*
SO_2	Sulphur Dioxide
SSHR	South Side Harbour Road
St. FX	Saint Francis Xavier (University)
TDS	Total Dissolved Solids
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
VECs	Valued Environmental Components
vpd	Vehicles Per Day
VSCs	Valued Socioeconomic Components

1.0 INTRODUCTION

Nova Scotia Department of Transportation and Public Works (NSTPW) proposes to construct and operate a 15 kilometre (km) fully controlled access, four-lane divided highway from Antigonish to South River, Nova Scotia (the Project). This Project is subject to federal and provincial regulatory approval under the *Canadian Environmental Assessment Act* (CEAA) and Nova Scotia *Environment Act* and *Environmental Assessment Regulations*. This document has been prepared to meet the Terms of Reference issued by the Nova Scotia Department of Environment and Labour (NSDEL) (NSDEL 2002a) for a harmonised federal/provincial environmental assessment.

1.1 Study Background and Objectives

The primary function of a 100 series highway network in Nova Scotia is the safe and efficient movement of large volumes of people and goods over long distances at high speeds while minimizing negative economic, social and environmental impacts (NSTPW 2001a). The Project is located near the Town of Antigonish and the community of Lower South River where the alignment parallels the existing Highway 104 for approximately 15 km from Addington Forks Road to Taylor Road. Traffic along this portion of Highway 104 has increased considerably since construction of the highway. The existing highway has high traffic volumes, including a high percentage of heavy truck traffic. It also has significant strip development and pedestrian activity. Traffic is a mixture of through and local traffic. Access is uncontrolled for most of this segment of the highway and the geometry is described as poor. These conditions are incompatible with a well functioning 100 series highway and have resulted in poor levels of service and safety performance.

Average daily traffic volumes on Highway 104 range from 10,000 to 15,000 vehicles per day (vpd) in the study area. The average number of accidents on this section of highway is 84.1 per hundred million vehicle km (HMVK) for the five year period from 1996 to 2000. This is above the Provincial average (61.0 per HMVK) for the same time period, as reported in the most recent publication of *Motor Vehicle Collision Rates for Numbered Highways and Sections 1996 to 2000,* for 100 series highways without access control (NSTPW 2002a). Completion of this portion of the National Highway System to 100 Series standards will increase safety and comfort for motorists and local residents using both the new and existing highways.

The highway design includes a fully controlled access, four lane, divided 27.6 m wide median facility with a design speed of 120 km/hr and a 35 m proposed centreline spacing. The proposed width of the right of way (RoW) is 150 m. The proposed alignment (refer to Figure 1.1) is intended to divert through traffic from the uncontrolled, heavily developed sections of the existing Highway 104 near Antigonish. The presence of ribbon development along the current highway is such that additional land was not available for highway expansion without directly impacting or significantly disrupting a large percentage of this development. Land acquisition would be costly and lost revenue compensation significant. Since upgrading of the existing alignment was not considered to be a feasible alternative, NSTPW initiated a route selection study in 1996 to identify lands suitable for preservation for a new four-lane 100 series highway.

In order to preserve a corridor and construct a four-lane highway, completion of the federal/provincial environmental assessment, detailed field survey and geometric design, and acquisition of the lands required for the RoW are first necessary. This process is estimated to take four to five years to complete. Subsequently, commencement of construction will be based upon prioritization of the project and the availability of funding.

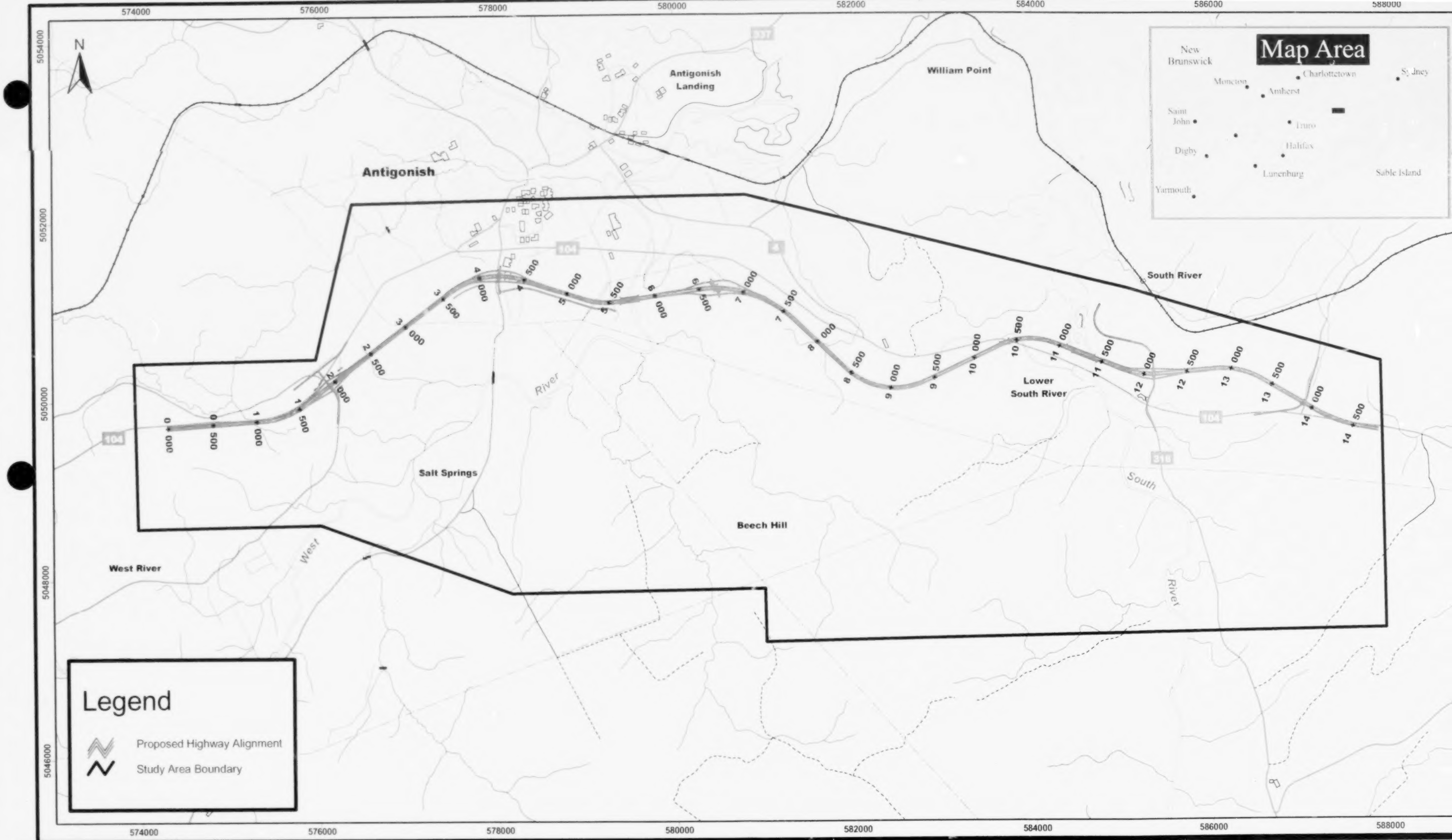
Highway 104 is part of the National Highway System and is therefore eligible to be cost shared by the Federal and Provincial governments. Eligibility for federal funding is dependent upon approval of the proposed Project under the *CEAA*. As the Project is over 10 km in length, it also requires approval as a Class II undertaking under the *Environmental Assessment Regulations* pursuant to the Nova Scotia *Environment Act*.

NSTPW has conducted a preliminary environmental screening, public consultation and a functional analysis of the proposed alignment as part of the preliminary planning for the Project. The Project has also undergone a detailed safety review, an independent peer review and a detailed assessment of environmental impacts at the proposed South River crossing.

The purpose of this report is to create an Environmental Assessment Report which meets both the requirements for a Class II Undertaking under the Nova Scotia *Environment Act* and an Environmental Screening under *CEAA*.

1.2 Organization of the Report

The Environmental Assessment (EA) Report is organized to reflect the process by which the assessment has been conducted. Section 1.0 introduces NSTPW and the undertaking, providing background information on the Project. Section 2.0 provides a description of the proposed undertaking. Construction activities are discussed as well as the purpose, location, scope and schedule for the Project. Alternatives to the Project and potential malfunctions and accidental events that may arise during construction and operation of the Project are described.



Jacques Whitford

NOVA SCOTIA
Transportation and Public Works

SCALE: 1 : 40,000
Date: 9/01/2004
Drawn By: GM
Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Project Location

0 0.5 1 1.5 2 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.
NSD16949
FIGURE 1.1

Section 3.0 provides an overview of the existing biophysical and socioeconomic characteristics of the study area. A summary of the existing environment is provided with respect to constraints listed in the NSTPW Highway Screening Criteria. Relevant legislation, regulations, and guidelines are also referenced where applicable.

A description of the environmental assessment methodology employed for this environmental assessment is provided in Section 4.0. Section 5.0 and Section 6.0 provide the results of the environmental effects assessment for biophysical components and socioeconomic components, respectively.

Section 7.0 provides a discussion of the potential malfunctions and accidental events, and mitigative measures that could occur during construction and operation of the proposed alignment. Section 8.0 includes a discussion of potential cumulative effects of the Project considered in conjunction with past, present and likely future projects in the study area. Section 9.0 discusses the effects of the local environment on Project activities and operation.

Section 10.0 details NSTPW's commitment to environmental management and provides a framework for compliance and environmental effects monitoring programs to be undertaken. A description of the public information programs initiated by NSTPW as well as planned consultation activities are provided in Section 11.0. A summary of the EA Report and conclusions from the EA are presented in Section 12.0. Section 13.0 details literature and personal communications cited in the report. A series of technical reports and other supporting information is contained in the appendices to this document.

1.3 Proponent Information

Name of Undertaking: Highway 104 Antigonish
Location: Nova Scotia

Name of Proponent: Department of Transportation and Public Works
Postal Address: PO Box 186
Halifax NS B3J 2N2
Street Address: Johnston Building
1672 Granville Street
Halifax, NS B3J 3Z8
Tel: (902) 424-2297
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Proponent Executive
Name: Mr. Brian Stonehouse
Official Title: Deputy Minister
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Email: stonebr@gov.ns.ca

Environmental Assessment Contact Person
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Email: pughel@gov.ns.ca

Signature of Executive

Date

2.0 PROJECT DESCRIPTION

2.1 Purpose and Need for the Project

The purpose and need for the Project are related to the increasing level of through traffic and truck traffic on the Antigonish to Lower South River segment of the existing Highway 104. Upgrading the existing highway to current 100 series controlled access standards was not feasible; therefore TPW initiated a route location study to identify lands suitable for preservation for a four lane divided highway alignment. The completion of the proposed section of highway will bring this segment up to required standards consistent with the remainder of Highway 104 from Amherst to New Glasgow.

The existing Highway 104 between Antigonish and Lower South River is a two/four lane highway with numerous intersections and driveways. This section of the highway is characterized by high traffic volumes, a high percentage of heavy truck traffic, poor geometry, uncontrolled access, strip development, pedestrian activity and a mixture of through and local traffic. The existing road includes 25 road intersections and some 76 entrances to residential, commercial, agricultural and institutional locations. The two/four lane highway, which must carry a mix of local and through traffic, poses safety concerns for local residents. The existing Highway 104 between Addington Forks Road and Taylor Road supports 9 different posted speed limits varying from 100 km/hr to as low as 60 km/hr. Two lane controlled access highways generally have speed limits of 100 km/hr.

The purpose of a 100 series highway is to provide safe, convenient, economic and efficient movement of persons and goods throughout the Province. The lack of vehicle access control and numerous conflict and decision points between traffic and pedestrians along the existing road are potential safety concerns. Also, the degree of roadside development and reduced speed limits (60 km/hr sections) affect the convenience, cost and efficiency of operation for through traffic. The purpose of this undertaking is to construct 15 km of the divided portion of Highway 104 to provide safe, convenient, economic and efficient movement of persons and goods.

Problems with existing highway to be resolved by the Project include: poor cross-sections; high traffic volumes; an increase in truck traffic; uncontrolled access from numerous intersections and driveways; extensive roadside signage and relatively high collision rates for a 100 series highway (NSTPW 2001a). Upgrading the existing route (*e.g.*, widening) is not a viable option as it would be cost prohibitive and disruptive to the ribbon development located in proximity to the existing highway over much of its length.

In 1996, the Atlantic Expressway Committee (AEC), recognized the need to replace or upgrade the existing Highway 104 in the near future and commissioned an economic impact study (Louis Berger (Canada) Ltd. 1996) of such a project. The AEC comprised representatives from the Town of Antigonish, Municipality of the County of Antigonish, Chamber of Commerce, Federation of Agriculture and St. Francis Xavier

University. The investigation indicated that traffic congestion and safety concerns would become a detriment to local businesses, and that the section from Antigonish to Lower South River required upgrading in the near future. Furthermore, it indicated that the economic impacts to the community increased as the distance from the existing alignment increased. The report recommended prompt collaboration between the community and NSTPW to identify and preserve a corridor that would minimize economic impacts. Consequently the AEC contacted NSTPW in the fall of 1996 to initiate a joint planning process to identify an appropriate alignment for the approximately 15 km section from the Addington Forks Road to the Taylor Road. Identification of the proposed alignment is the result of the efforts of the AEC and NSTPW to provide a safe travelling environment while maintaining economic viability of businesses in the community.

2.2 Project Scope and Location

The scope of the Project to be assessed includes construction, and operation and maintenance of the 15 km controlled access four lane divided highway between the Addington Forks Road (west of Exit 31) and Taylor Road (west of Exit 35) along the existing Highway 104 in Antigonish County. Decommissioning and abandonment of the proposed highway is not planned. The location of the Project is shown in Figure 1.1. The alignment closely parallels, within 600 m, the existing Highway 104. The proposed RoW follows south of the existing Highway 104 until it traverses to the north of the highway just west of the South River. Full diamond interchanges are proposed to connect with the existing Highway 104 at Addington Forks Road, Trunk 7, Beech Hill Road and Route 316. Overpass structures are proposed to ensure continued access along Beech Hill Road, and the existing Highway 104 between the South River Loop and Dunn's Loop. Underpass structures are proposed to maintain access where the highway intersects with Route 4 at Addington Forks, Trunk 7, at Route 313 where it joins with the new alignment of South Side Harbour Road, and at Taylor Road. The estimated cost of constructing the 15 km highway and associated structures is $65 million (NSTPW 2001a), excluding property acquisitions.

2.3 Project Schedule

Planning for the proposed alignment began in 1996 with NSTPW staff working with the AEC to identify an alignment, including access locations. An environmental screening conducted by the NSTPW in 1996 identified environmental, social and economic constraints associated with the study area. Three open house public meetings were held by NSTPW to gather public input on routing. At the first open house, held in May 1997, potential constraints and broad study corridors were identified in which alignment alternatives could be investigated. Constraint identification assisted NSTPW in focussing on three preferred alignments which were developed by April 1998 and presented at the second open house, in May 1998, along with proposed interchange locations. One of the main concerns at the 1998 open house was safety. A detailed safety review of the alignment options was completed in February 1999. Also in 1999, the alignment selection and planning process was subjected to an independent peer review. The results of these studies, previous public consultations, input from other government agencies, and background and further investigation by NSTPW helped define the preferred alignment for EA registration. The preferred alignment was presented at the third open house meeting in May 2001. NSTPW registered the Project with the Nova Scotia Department of Environment and Labour (NSDEL) in November 2001. A Terms of Reference for the environmental assessment was subsequently released by NSDEL in February 2002. This document has been prepared to meet the Terms of Reference issued by NSDEL for a joint federal/provincial environmental assessment. Highway construction cannot proceed until the approvals process, survey work, detailed design and property acquisition have been completed. The earliest possible construction start-up, assuming availability of funding, is Fall of 2006 (NSTPW 2001b).

In general, construction activities will be scheduled to avoid potential interactions with VECs during sensitive periods (*i.e.*, breeding periods) where: recommended as specific mitigative measures (Section 5); recommended as general protection practices (Section 2.4); or to comply with specific required permits and conditions. For example, instream work at watercourses will generally be limited to the period from June 1 through September 30, as per Nova Scotia Water Approvals, and Nova Scotia Watercourse Alteration Specifications (NSDOE 1997) to avoid fish migration and periods of higher precipitation and runoff potential.

In general construction scheduling will depend on the prioritisation of this Project with other Provincial highway construction projects, and the availability of funding.

2.4 Construction Activities

This section provides a brief description of Project construction activities. The activities described are those typically involved in highway construction in Nova Scotia. Construction activities potentially affecting the environment will be conducted according to: NSTPW Standard Specifications (1997 and revisions); Province of Nova Scotia Environmental Construction Practice Specifications (Fisheries and Oceans Canada *et al.* 1981); and the Environmental Code of Good Practice for General Construction (Environment Canada 1979). Other relevant guidelines include the Environmental Code of Good Practice for Highways and Railways (Storgaard and Associates 1979) and Erosion and Sediment Control Handbook for Construction Sites (NSDOE 1988). Mitigative measures for, and response to, malfunctions and accidental events are discussed in Section 7.

The design of the road and structures which make up the highway will be carried out such that contractors have clear direction for environmental controls made available to them both on the contract drawings and in the Project specifications in the form of an Environmental Protection Plan (EPP). These measures may include those described in: the EA Report; conditions of release from the assessment process; and other regulatory requirements and best management practices. NSTPW has a generic EPP which will be modified according to specific requirements of this Project.

The following description of the proposed highway construction incorporates available information specific to this Project (*i.e.*, plan and profile data and route geometry), as well as general information regarding activities that are typical of highway construction in Nova Scotia.

2.4.1 Clearing

The first phase of major construction activity will be clearing of the proposed alignment. Approximate width of clearing for the four lane highway will require clearing the right-of-way (RoW) to a width of approximately 50 m (25 m each side of the centerline), with the exception of a few areas where greater widths are required to accommodate the interchange and deep cuts and fills. Clearing width will vary depending on the toe of the slope (*i.e.*, 4 m from the toe of slope or top of cut). The primary environmental concern during clearing of the RoW is to minimize ground disturbance which may result in the erosion and sedimentation of wetlands and watercourses. The NSTPW Standard Specifications (1997 and revisions) outline procedures for clearing. Trees will be cut to within 0.3 m of the ground. Marketable timber (minimum butt diameter of 100 mm and a length of 2.5 m) will be delimbed and removed from the site, while non-salvageable material will be chipped within the RoW and left in place.

Isolated or ornamental trees will be designated by the Project Engineer and shall be removed and relocated in accordance with NSTPW's Standard Specifications (1997 and revisions). Removal will be done by excavating the tree and removing the total tree including stump and roots, limiting the damage to the surrounding property.

Where possible, clearing operations will be conducted during winter months as frozen ground provides the necessary bearing capacity for heavy machinery, protecting the underlying vegetative mat. Working on frozen ground makes the work site more accessible, reduces the cost of access road development, and increases the speed at which skid trails can be used. Hand clearing will be conducted where ground conditions are not suitable for heavy equipment access, *e.g.*, within watercourse and wetland buffer zones.

2.4.2 Grubbing

Grubbing for roadway construction involves the removal of all organic material and unsuitable soil above the underlying soil. It also consists of the removal and disposal of all stumps, roots, downed timber, embedded logs, humus, root mat and topsoil from areas of excavations and embankments or other areas as directed by the Project Engineer. All areas where fills are less than 1.5 m or where excavation is planned, must be grubbed. Grubbing is usually not required under fills greater than 1.5 m in depth, unless a structure (*e.g.*, bridge, culvert or retaining wall) is to be constructed, or where there is a significant layer of compressible soil that could cause a future settlement problem. To minimize environmental risks associated with erosion and sedimentation, grubbing is conducted only after the installation of culverts, and required erosion and sediment controls (*e.g.*, sediment fence, settlement ponds, etc.) are in place.

Bulldozers are typically used to scrape the organic material off the underlying soil and to pile the material. If the grubbed material is to be removed from the site, track-mounted excavators are sometimes used to load the material on to dump-trucks. Where grubbing involves the removal of extensive organic deposits (*i.e.*, peat), the material is usually removed by an excavator and loaded directly to dump-trucks. If the deposit of unsuitable material cannot be removed with a track mounted excavator, a drag-line excavator is often used.

The projected end use of the grubbed material and the method of disposal dictate whether incidental organic materials such as stumps, roots, etc. are removed prior to re-use or disposal. Some stumps may be removed from the grubbed material and chipped. Grubbed soil may also be used to flatten the slopes of embankments along the roadway, depending on its quality and the need for fill at the site. Topsoil will be salvaged for use in the median and on side slopes as per NSTPW's Standard Specifications (1997 and revisions). Other grubbed material is disposed of as indicated in Section 2.4.11.

2.4.3 Structures

The proposed RoW contains 16 watercourse crossings. It is anticipated that most of these crossings will be accomplished using culverts. Culvert installations at watercourse crossings are normally accomplished by constructing temporary stream diversions, allowing the culvert to be bedded 'in the dry' and backfilled prior to conveying the stream through the culvert. Applicable siltation and erosion control practices will be adhered to during this process. Culverts will be designed so as not to interfere with use of the stream by fish.

Culverts would be constructed of either cast-in-place concrete or precast concrete and can be either three-sided (open bottom) or four sided. A typical box culvert would have a maximum inside clear span of 3.6 m. Two or more lines of box culverts may be placed side-by-side to create twin or multi-barrel box culvert installations for wider watercourses. Refer to Section 5.3 for more information on watercourse crossings.

In sensitive streams that are known to be fish bearing, a short span precast bridge structure or open bottom culvert could be used. These types of structures reduce impacts on the streambed. For watercourse crossings greater than 10 m in width, a bridge structure is generally considered.

All crossings of watercourses are normally designed to accommodate the 1 in 100 year storm for the local region as defined by data from the Atmospheric Environment Service of Environment Canada. These estimates will incorporate anticipated changes in precipitation due to global warming.

Appendix B contains a hydrological study of the watercourses to be crossed by RoW. No significant hydraulic changes are expected during construction or operation of the highway. Due to the wide channel and the steep bank that exists at the West River crossing (5+700), a free-spanning structure will be considered at this location. It is noted that this type of structure is very expensive and alternative options will also be explored. The crossing at the unnamed watercourse located at 8+150 has steep banks and contains good fish and wood turtle habitat; TPW will consider an arch at this location. The proposed South River crossing has been addressed in a previous report (Neill and Gunter Ltd. 2001) and was not therefore included in the hydrological survey. See Appendix E for this report.

The hydrologic functions at the proposed South River crossing are primarily conveyance and flood storage. Construction will not impact conveyance and will displace a negligible amount of flood storage capacity. The recommended structure for this crossing based on the impact study is a four span steel girder structural system with a concrete deck. The location of the crossing considered the environmental sensitivity at all sections across the river valley.

Estimates of run-off volumes and design of run-off control features will be made during final highway design process using standard highway design criteria once the alignment and profile have been finalized. All instream work will be conducted during low-flow periods (June 1 - September 30) to avoid interference with fish spawning, incubation and hatching activities. Further detail on watercourse construction activities is provided in Section 5.3.5.1.

Construction of structures will begin with the installation of properly designed siltation and erosion control measures followed by clearing and grubbing, excavation, embankment fills, etc. as required. The foundations for abutments and piers will be cast-in-place reinforced concrete on either spread footings or piles. The prefabricated girders, either of pre-stressed concrete or steel construction, will then be put into place using cranes. The bridge deck will be constructed of cast-in-place reinforced concrete, a waterproofing membrane will be applied and the surface will be paved to match the design grade of the road surface at that point.

Wildlife crossings/underpasses will be considered to minimize effects of habitat fragmentation and wildlife mortality (road kill) (refer to Sections 5.4, 5.5 and 5.8). The design and construction of these structures will coincide with planned culvert/bridge crossings and will draw upon experience and observation of the effectiveness of established wildlife crossings on existing highways in Nova Scotia (e.g., wildlife tunnels on the Cobequid Pass) and other areas in North America (e.g., salamander tunnels in Amherst, Massachusetts) (FHWA 2000). Refer to Sections 5.4, 5.5 and 5.8 for more information on wildlife crossings.

2.4.4 Major Cut / Fill Operations

Many cuts and fills will be required throughout the proposed Highway 104 alignment to provide an appropriate vertical alignment in the rolling terrain prevalent throughout the study area. Changes in vertical alignment involving cuts and fills are also required on the approaches to highway overpasses or underpasses of other roads, and watercourses.

The vertical alignment of a highway consists of straight grades, and crest (hill tops) and sag (valleys) vertical curves. The highway will be constructed as a four lane divided roadway with a wide median and the limiting design criteria for vertical curves is based on comfort and safety. Vertical curves must be sufficiently 'flat' so vehicle occupants do not feel uncomfortable on crests or sags. The design of vertical curves must also consider provision of adequate stopping sight distance and headlight visibility.

Cuts and fills of greater than 6 m are generally considered to be 'major' operations. Fifteen sections containing major cut and fill operations, identified from the NSTPW centerline profile, are shown in Table 2.1. The 'start' chainage for the affected section begins where the cut or fill first exceeds 3 m, and continues through the critical area to the 'end' chainage where the operation becomes less than a 3 m depth.

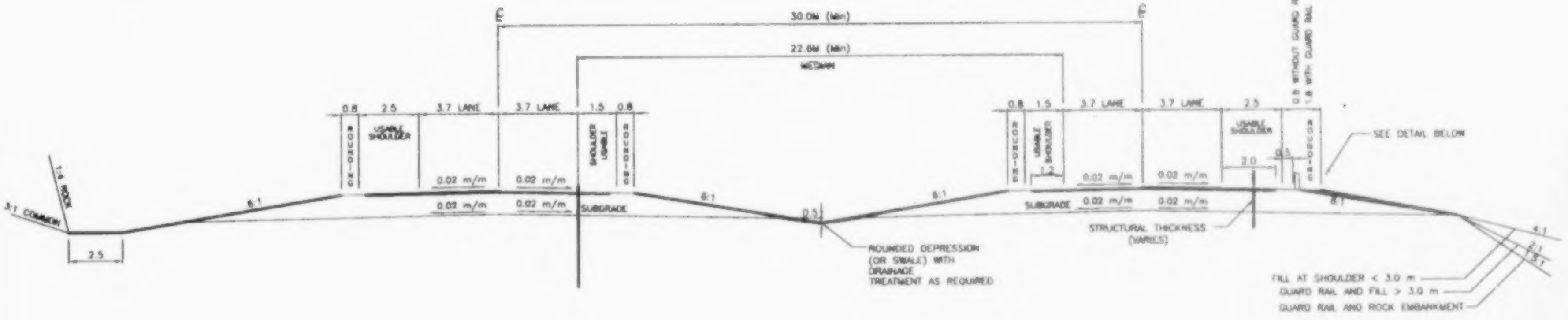
Table 2.1 Major Cut and Fill Operations

No.	Type	Start Chainage	End Chainage	Length (m)	Approximate Deepest Point (m)	Comment
1	Fill	2+350	2+450	100	8.0	Stream
2	Cut	4+240	4+450	210	7.5	-
3	Fill	5+630	5+870	240	9.5	West River
4	Cut	5+900	6+200	300	11.0	-
5	Fill	6+350	7+000	650	9.5	Beech Hill Rd. and a stream
6	Cut	7+230	7+410	180	8.5	-
7	Cut	7+770	7+890	120	8.0	-
8	Fill	8+000	8+200	200	10.0	Stream
9	Cut	8+430	8+760	230	9.0	-
10	Fill	8+820	9+550	730	23.0	Wetland
11	Cut	9+620	10+090	470	11.0	-
12	Cut	10+270	11+190	920	18.5	-
13	Fill	11+230	11+610	380	13.0	South River / South Side Harbor Rd.
14	Cut	11+670	11+860	90	10.5	-
15	Fill	12+990	13+290	300	6.1	Wetland

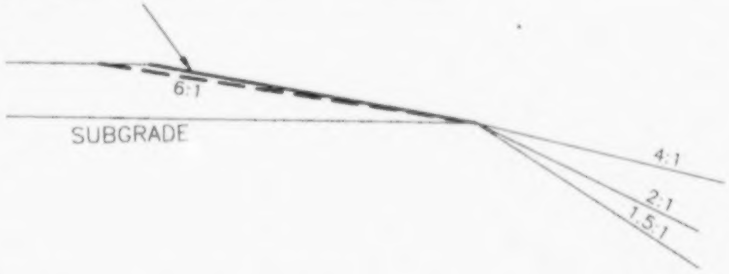
Source: NSTPW 2002 - Proposed Centerline Profile

Several factors are considered in the design of major cut and fill sections including: slope stability; erosion control; silt and runoff control; location and rehabilitation of borrow pits; impacts on groundwater; and impacts on blowing snow.

Stability of slopes for both cuts and embankments will be considered along the proposed alignment, and connectors. As per NSTPW's Standard Cross Section (Figure 2.1), conservative slopes for cuts and embankments will not generally exceed 3 horizontal : 1 vertical; slopes may be steeper in rock, rock fill, and guardrail locations (*e.g.*, 2:1). Cut slopes in soils tend to undergo minor sloughing where high groundwater and freeze-thaw occurs. These are typically repaired using a layer of rockfill to facilitate drainage. However, such analysis is site-specific and is dependent upon the specific soil type, geological features and elevation of the water table.



NOTE: Structural Thickness sideslope to change where guardrail installed.
(Subgrade width to remain constant.)



NOTES:
- WIDTH OF SUBGRADE IS DEPENDENT UPON STRUCTURAL THICKNESS WHICH SHALL BE DETERMINED BY PAVEMENT DESIGN
- ALL DIMENSIONS ARE IN METRES

NOVA SCOTIA
Transportation and Public Works
Highway Planning & Design

Figure 2.1
Typical Cross Section
Freeway Open Median

Manager Highway Planning & Design

Director Highway Engineering Services

Executive Director Public Works

Scale : N.T.S.
Drawn by : M. LaBreche
Checked by : S. Shannon

Date of Plan : 06Mar/02
File No. : FreewayOpen.dwg
Path: G:\M\HPandD\H D D\Std\Freeway Open Med8.5x11.0.dwg

The overburden soils anticipated to be encountered along the proposed alignment will likely be susceptible to erosion. Several generic measures that can be taken to minimize sedimentation and erosion potential include: fitting the development to the terrain; construction sequencing to minimize soil exposure; retaining existing vegetation as long as possible; vegetation and mulching of grubbed areas; diverting runoff away from denuded (*i.e.*, bare) areas; minimizing length and steepness of slopes; keeping runoff velocities low; properly sizing and protecting drainage ways and outlets; intercepting sediments on site; and inspecting and maintaining control measures.

Erosion and consequent siltation due to direct run off is only a concern to dug wells in very close proximity to the alignment (*e.g.*, a few 10s of metres) and where direct overland flow of silt occurs. Impacts to surface watercourses by uncontrolled erosion are a more important concern (Section 5.3).

2.4.5 Excavation

The removal of material for the construction of sub-grade (bottom layer of material) may involve one o more methods of excavation including common excavation, rock excavation, and swamp excavation Common excavation is the removal of overburden, including till, smaller boulders, and topsoil. Roc excavation is the excavation of rock which is considered to be bedrock or single pieces greater than on cubic metre in size. Cuts in 'soft' rock can be accomplished using ripper blades attached to the back o larger bulldozers, breaking up the rock so that it can be loaded on to trucks with an excavator or loader. Thi procedure tends to be successful in softer rock such as shales and sandstones, and in areas where the bedroc surface is highly weathered and/or fractured.

Swamp excavation occurs where soil is unsuitable for use as a sub-grade. The soil is either excavated an replaced with a competent fill, or 'floated over' using geogrids or berm construction. This may occur whe peat is encountered or when exposed soil has been saturated with water. Excavated soils unsuitable for us as fill or dressing slopes are disposed of at a site approved by the Project Engineer.

Stability of slopes for both cuts and embankments will be considered along the proposed alignment, an connectors. Conservative slopes for cuts and embankments will not exceed 3 horizontal :1 vertical in san and gravel as well as in cohesive soils (silts and clays). Less steep slopes will be used if necessary.

2.4.6 Blasting

The use of blasting for rock excavation is dependent upon the competency of the rock. The contractor wi determine whether or not blasting will be required for the construction of the proposed alignment. Wherev possible, rock excavation will be performed by ripping rather than blasting, due to the lower costs involve

Based on overburden thickness and lithology (physical character of the rock), blasting is expected to be minor along the alignment (refer to Section 5.2). The bedrock is composed of relatively 'soft' sandstone, mudstone and limestone which should require much less blasting energy to excavate than other areas of Nova Scotia.

If blasting is deemed to be necessary, blasting operations will be conducted in accordance with the applicable regulations and guidelines. Blasting operations are governed by provincial regulations throughout Nova Scotia. Blasting in or near watercourses will require approval from the Department of Fisheries and Oceans (DFO), and will be conducted in accordance with the "Guidelines for Use of Explosives in or Near Canadian Fisheries Waters" (Wright and Hopky 1998). Blasting will also be conducted in accordance with the *General Blasting Regulations* made pursuant to the Nova Scotia *Occupational Health and Safety Act*. The contractor performing the blasting will have a valid 'Blaster's Licence' and will ensure that a pre-blast survey has been conducted, prior to blasting (see Section 10.3).

2.4.7 Highway Construction

Highways in Nova Scotia are generally constructed in three distinct layers:

- **Sub-grade** is the bottom layer in which the original ground level is adjusted to form the roadbed. The sub-grade is constructed by using materials from cut operations or borrow pits to construct fill embankments.
- **Sub-base and Base** include granular materials, crushed stone or gravels, of various sizes and appropriate depth placed on top of the sub-grade to provide drainage and strength.
- **Pavement** is placed on top of the granular material to reduce moisture penetration of the under layers, add strength, and finally to provide a smooth riding surface.

2.4.7.1 Sub-grade

Sub-grade is the bottom layer of material on a road, providing strength and stability. Sub-grade is constructed by dumping acceptable fill, either from cuts or borrow sources, spreading it in a layer of specified thickness (depending on the engineering properties of the material but not usually exceeding 300 mm), and, using moisture control procedures, compacting it to a specified density. Subsequent layers are added until the desired elevation is reached.

Where feasible, as determined by suitability of the material and hauling costs, material excavated from the RoW is used for fill. If the excavated material is determined to be unacceptable for use as road building material along the alignment, or if there is a shortage of usable materials, materials will be obtained from nearby borrow sources (see Section 2.4.8).

2.4.7.2 Sub-base and Base

Once the sub-grade has been developed, a granular graded structural base known as sub-base and base is prepared. The sub-base course (gravel) is placed immediately above the sub-grade and consists of material superior in quality to that used for sub-grade. The base course is placed immediately above the sub-base and consists of a series of layers graded to provide structural integrity and good drainage beneath the asphalt concrete surface.

2.4.7.3 Pavement

The majority of pavement used in Nova Scotia is the familiar black asphalt. An asphalt pavement surface is planned for the study area of Highway 104. Although evaluation studies of the costs and performance of concrete pavement are ongoing, asphalt pavement is typically used in Nova Scotia. This material is made by mixing petroleum based liquid asphalt with sand and crushed stone in an asphalt plant. The hot mix is easily transported, spread and rolled to provide a smooth surface that can be used almost immediately. Special care must be taken in the design and placement of granular and asphalt pavement layers to minimize wheel track rutting and frost action that may break the pavement and cause surface failures (*i.e.*, pot holes).

Portland cement concrete is an alternative type of pavement. However, the high initial capital cost relative to conventional asphalt concrete makes it a generally less attractive paving option. The material is made by mixing Portland cement, sand, gravel, and water at a concrete batch plant. The concrete mix material is transported by trucks and placed by a slip forming machine that automatically creates joints complete with steel joint dowels to ensure that adjacent slabs retain their alignment. Concrete must set or cure for several days before it can be opened to traffic. Although it has a higher initial cost than asphalt pavement, concrete pavement is rigid and provides a smooth riding surface which is not subject to rutting and generally resists frost action and pot holes. In recent years, NSTPW has been evaluating concrete pavement on an approximately 4 km long section on the Highway 104 westbound lanes east of Oxford. This section, constructed in 1995, has provided excellent performance. NSTPW plans to further evaluate concrete pavement by placing a 10 km section on Highway 101 between Mount Uniacke and Ellershouse.

Both pavement types require durable crushed stone that will meet TPW specifications. Provision of crushed stone will be the responsibility of road construction contractors, who will abide by appropriate pit and quarry regulations. It is expected that stone for pavement mixes will be obtained from existing quarries near the study area.

2.4.8 Borrow Materials

Construction of the highway will consist of cuts and fills to bring the area to sub-grade level using materials along the alignment. Based on the surficial and bedrock geology most of the materials used in the sub-grade construction will consist of glacial tills and bedrock of the Mabou and Windsor Groups. Some alluvial type sand and gravel deposits exist in the western end of the Project and in the area of Lower South River. Borrow material required for sub-grade construction will probably be derived from glacial till and glacial fluvial materials found near the alignment. As noted in Section 5.2.2, Overburden Geology, the glacial tills are relatively fine grained. They tend to be suitable as a sub-grade fill material but are sensitive to moisture and are difficult to work with during wet periods of the year. Both tills and glacial fluvial materials are also erodible and erosion/sediment control measures will be necessary at borrow pits and along the alignment where these materials are used.

Rock fill may be used as borrow material, but tends to be more expensive to obtain than the glacial till. Aggregates for the Project will be required for such items as sub-base and base gravels, shoulder gravel, asphaltic concrete, backfill for structures and culverts, erosion protection, stream bank stabilization, etc. Pomquet Formation (mudrock and minor limestone) and Hastings Formation (sandstone and mudrock) bedrock underlies the eastern and western ends of the alignment and Hood Island Formation (siltstone, limestone, dolostone, gypsum and anhydrate) bedrock underlies the central two thirds of the alignment. It may be possible to excavate quarries near the Project within these formations to produce these aggregates. Aggregates for Portland Cement Concrete and the concrete will be provided by prequalified Ready-Mix Concrete producers in accordance with the NSTPW Specification Division 5, Section 7. All aggregates are prequalified and will meet the requirements of the Department.

2.4.9 Hydroseeding

Hydroseeding will be conducted as soon as possible after completion of the surface preparation. Table 2.2 shows the composition of seed mix currently used by NSTPW.

Table 2.2 Composition of Seed Mix for Hydroseeding

Common Name	Botanical Name	Percentage of mix (%)
Creeping red fescue	*Festuca ruba*	40
Timothy	*Phleum pratense*	15
Tall fescue	*Festuca arundinacea*	15
Kentucky Blue Grass	*Poa pratensis*	10
Alsike clover	*Trifolium hubridum*	10
Red top	*Agrostis alba*	5
Perennial rye	*Lolium perenne*	5

Source: NSTPW (1997 and revisions)

Areas to be hydroseeded will be dressed or otherwise left in a loosened condition conducive to seeding. Hydroseeding will not be performed under windy conditions or during periods of rainfall, on areas covered by standing water, or frozen surface or under other adverse conditions, as determined by the Project Engineer. Hydroseeding will be carried out as soon as possible after surface preparation is completed.

Application rates and procedures as detailed by NSTPW's Standard Specifications (1997 and revisions) for hydroseeding will be implemented.

2.4.10 Construction Vehicle Operation

Vehicles used in sub-grade construction typically include excavators, bulldozers, rollers, trucks, and graders. Most of these vehicles operate on diesel fuel and require some form of daily maintenance. The vehicles typically operate continuously for 12-hour shifts. Truck traffic during sub-grade construction will primarily be confined to on-site operations, and transportation of material for cut and fill operations. Some truck traffic will occur off-site to travel to adequate borrow and/or disposal sites. Specific information on vehicle operation is unknown at this time since specific borrow and disposal volumes and locations have not yet been identified.

Vehicles typically used in base and pavement construction include pneumatic tire and steel drum rollers, graders, trucks, and asphalt concrete pavers. If the asphalt concrete plant is located on-site and a suitable source of aggregate used for the asphalt concrete and road base construction can be found on-site, truck traffic during this phase of construction would be limited to the delivery of prime, tack coat, asphalt cement and diesel fuel. If the asphalt concrete plant is not located on-site and/or aggregate must be obtained from another source, the amount of truck traffic on the access roads would increase accordingly.

2.4.11 Construction Waste Disposal

The most desirable use of material excavated from the RoW during construction is use within the RoW (*e.g.*, buried in the toe of the slope), assuming it conforms with NSTPW standards. Disposal of waste materials from the construction of the proposed undertaking will be in accordance with NSTPW's Standard Specifications (1997 and revisions) for highway construction and any provisions included in site-specific contracts. The current specifications for clearing and grubbing do not include any specific criteria for the selection of waste disposal sites. Disposal sites are to be located by the contractor and must be approved by NSTPW.

Non-salvageable material from the clearing operations, such as limbs and non merchantable timber, are typically chipped within the RoW and left in place except within buffer zones for watercourses and wetlands. Occasionally, large items which cannot be easily chipped (*i.e.*, stumps) are buried on adjacent land. Excavated organics, overburden and rock must be disposed of where their use as fill material is impractical. According to the Nova Scotia Watercourse Alteration Specifications (NSDOE 1997), waste disposal areas must be located such that they do not interfere with any stream or drainage facility (*i.e.*, >100 m away), do not contribute to erosion and/or siltation, and are left in a neat appearance. Disposal of potential acid generating bedrock, if encountered, will be conducted in compliance with the *Sulphide Bearing Material Disposal Regulations*.

2.4.12 Acid Producing Bedrock

Acid drainage problems have long been associated with mining related activities in Nova Scotia and in the past 20 years such problems have also been identified with corridor-type developments such as highways. In Nova Scotia, excluding mining projects, acid drainage problems have been almost exclusively associated with developments in the Halifax Formation Slates. Presence of the Halifax Formation bedrock is not anticipated along the proposed Highway 104 alignment.

Where acid producing bedrock is identified as a potential constraint during the planning design process, NSTPW implements various avoidance measures including raising the road profile, shifting the alignment and minimizing width of RoW. Acid producing bedrock is not expected to be encountered on this Project, therefore these measures were not necessary.

As outlined in Section 5.2.2, Bedrock Geology, the RoW is underlain by five geological formations: the Mabou Group Pomquet and Hastings Formations and the Windsor Group Hood Island, Bridgeville and Gays River Formations.

A site reconnaissance was carried out on October 10 and 11, 2002 to observe bedrock exposures. All roads along the proposed RoW were traversed to determine the accuracy of the geological mapping. No bedrock outcrops were observed within the areas investigated at the time of the field reconnaissance, due to the presence of thick glacial overburden. Bedrock exposures could occur along streams and rivers where the overburden has been eroded. However, based on the current highway alignment, acid producing bedrock is not expected to be encountered during construction.

2.4.13 Karst Topography

Karst is a distinctive landscape topography typically formed by dissolving carbonate rocks such as limestone, dolomite and marble, or other highly soluble rocks such as halite, gypsum and anhydrite. The geological process involved can result in unusual surface and subsurface features ranging from sinkholes, irregular surface topography, vertical shafts, disappearing and reappearing springs as well as complex underground drainage systems and caves.

Throughout Nova Scotia the formation of Karst Topography is typically associated with areas underlain by Carboniferous rocks of the Windsor Group which contain the rock types noted above. Karst is known to occur in several areas around Antigonish County, including the Lower South River area near the RoW. A borehole investigation conducted at the proposed South River crossing (Neill and Gunter Ltd. 2001) revealed that the contact between the Mabou Group (formerly the Canso Group) and Windsor Group underlies the South River. The Hood Island Formation of the Windsor Group was confirmed approximately 20 m north of the existing Highway 104, west of the backwater channel of the South River. Limestone bedrock was encountered at approximately 14 m from the surface, however Karst topography was not encountered during the borehole investigation.

Windsor Group rocks occurring along the alignment consist of the Hood Island Formation, which underlies approximately 7 km of the route. The rocks in this formation consist of red siltstone and sandstone with intercalated marine limestone and dolostone and minor gypsum.

Geological mapping by R. C. Boehner and P. S. Giles (1993) indicates minimal occurrence of soluble rock and limited outcropping of other sedimentary rock types along the proposed highway alignment. The overburden throughout the area generally comprises relatively thick deposits of fine grained glacial till which forms gently rolling terrain masking the underlying bedrock features.

A walkover survey of the alignment (October 10 and 11, 2002) was carried out and observations were made for evidence of Karst Topography. There were no areas noted where evidence of Karst occurred along the alignment. The proposed alignment crosses the same geology as the existing Highway 104 where there have been no issues identified associated with Karst development. Problems associated with Karst along the parallel section of highway are not anticipated.

The review carried out indicates there is risk of subsidence features developing along the alignment due to the underlying bedrock. However, observations of the current surface conditions suggest that active Karst development has not occurred within this area.

2.4.14 Contaminated Sites

There are several gas stations and autobody shops along the RoW. While these properties have not been specifically investigated for this assessment, it should be noted that these types of land uses are more susceptible to potential contamination. If contaminated soils are encountered, the sites will be managed in accordance with the Guidelines for Management of Contaminated Sites in Nova Scotia (NSDOE 1996). If a potentially contaminated site is encountered, the owner of the site will be notified. The site will be evaluated in a timely manner to determine whether there are off-site impacts or unacceptable on-site impacts. If impacts or risks are identified, the owner is required to: advise affected third parties, if appropriate; determine whether active remediation or ongoing site management is to be implemented; and submit a contaminated site Notification Report to NSDEL.

2.4.15 Erosion and Sediment Control

Erosion is defined as the gradual wearing away of the land surface by the action of water, wind, ice and gravity. Sedimentation is the deposition and accumulation of detached soil particles. The emphasis in all NSTPW construction projects is to control erosion rather than treat sediment. The most effective way to ensure that sediment does not affect the environment is to prevent erosion and transportation of sediment-laden run-off.

NSTPW's principles of erosion and sediment control include:

- minimize the amount of exposed soil;
- minimize the amount of time soil is exposed;
- avoid steep slopes;
- keep sediment on site (avoid sediment transport); and
- ensure that clean water remains clean.

To minimize the environmental risks associated with erosion and siltation during highway construction, the Project will be carried out according to NSTPW's Standard Specifications (1997 and revisions), NSDOE's Erosion and Sedimentation Control Handbook for Construction Sites (1988), and the Environmental Construction Practice Specifications (Fisheries and Oceans Canada *et al.* 1981).

NSTPW's work progression schedule will ensure construction in any work area is carried out continuously from initiation to completion thereby minimizing exposed soil on construction sites. Site specific Erosion Control Plans will be developed for the Project and will specify where the installation of erosion and sediment control features will be located. These will be approved by NSDEL under Part V Water Approval process prior to culvert installation. For more information on erosion and sediment controls, refer to Section 5.3.

2.5 Highway Operation and Maintenance

The maintenance activities described below will be conducted throughout the operational life of the proposed roadway. These activities are typical of maintenance activities on Nova Scotia highways. Mitigative measures and response to malfunctions and accidental events that may occur during highway operation and maintenance are discussed in Section 7.

Resurfacing

The rate of degradation of the pavement surface will be determined by the volume of traffic, proportion of heavy trucks, certain vehicle characteristics (*i.e.*, radial tires), structure and quality of pavement structure. The repair of the asphalt concrete surface may involve excavation or removal of the existing pavement and sub-grade, levelling, patching, surface treatment and asphalt concrete overlays. Disruption to the public from these repairs would be temporary and infrequent in nature.

Drainage

Periodic maintenance of roadway drainage systems may be required. This may involve the replacement or repair of culverts and re-establishment of the drainage ditches.

Clearing

Regrowth of vegetation within the RoW may interfere with the lines of sight required for safe use of the highway. Clearing along the RoW is part of NSTPW's regular maintenance to maintain sight lines and may involve both manual and mechanized cutting.

If herbicide application is required for the control of noxious weeds, trained personnel will apply herbicide subject to permit approval issued by the NSDEL pursuant to the *Pesticide Regulations* under the Nova Scotia *Environment Act*.

Winter Maintenance

NSTPW applies approximately 260,000 tonnes of road salts each year. An additional 500 staff are hired each winter, bringing the total work force on the Highways Operations Division to 1,400. The department uses approximately 400 plows for winter maintenance, including graders, trucks, and four-wheel drive vehicles. NSTPW already has several initiatives underway to help manage the use of road salts. These initiatives include:

- construction of several additional salt/sand storage structures to increase covered storage capacity;
- installation of Road Weather Information System (RWIS) sites (approximately 24 in operation by 2003);
- new winter maintenance standards to provide a consistent and measurable level of service for ice and snow removal to all areas of Nova Scotia; and
- upgrading of salt spread truck fleet through the installation of computerized salt controls, infrared pavement temperature sensors, and retrofitting of some trucks with pre-wetting capability.

In 2000, NSTPW implemented a pre-wetting trial on a section of 100 Series Highway in Halifax County. The pre-wetting operation involved the application of a sodium chloride (NaCl) brine solution to the road salts just prior to application on the highway. Pre-wetting was carried out in an effort to reduce the loss of road salts applied to highways due to wind and traffic disturbance. The trial proved that pre-wetting was a useful tool to reduce road salts. Savings in road salts of up to approximately 10-12 % were realized while the same level of service was maintained. The pre-wetting program was expanded in 2002 and is now being used in areas where RWIS sites have been established. Further reductions in road salts can be realized if placed just prior to a storm event. This is usually referred to as 'anti-icing' as opposed to 'de-icing'.

In response to Environment Canada's recent policy on road salt, NSTPW has developed a Salt Management Plan (SMP). The SMP provides a mechanism through which NSTPW can commit to implementing salt best management practices while fulfilling its obligation to providing safe, efficient, and cost effective roadway systems. Additional detail on NSTPW's SMP and a salt management strategy for this Project are included in Appendix L.

Other Maintenance Activities

Other road maintenance activities include shoulder grading, localized pavement repair, and line repainting. Disruption to the public from these repairs will be temporary and infrequent in nature.

2.6 Decommissioning

The highway will be maintained as necessary for an indefinite period of time. Decommissioning, if required in the future, will be undertaken in compliance with relevant laws, regulations and guidelines current at that time.

2.7 Project Alternatives

2.7.1 Alternatives to the Project

Alternatives to the Project are defined as functionally different ways of achieving the same end (CEA Agency 1994). Alternatives to the Project include: the 'do nothing' scenario (null alternative); upgrading the existing alignment (*i.e.*, widening the existing highway); or other modes of transportation *(i.e.,* rail, bus).

The objective of the Project is to provide a four lane divided controlled access highway to accommodate the high traffic volumes prevalent throughout the study area from west of Addington Forks Road to east of Taylor Road. Three alternatives to the Project are discussed briefly, however, there are no practical or possible alternatives that will satisfy the objective.

'Do Nothing' - If action is not taken, traffic volumes will continue to increase and the potential safety problems created by the mix of local and through traffic will continue. The existing uncontrolled access section of Highway 104 will continue to operate at reduced speeds and through traffic will not benefit from the improved levels of service that exist on other sections of improved 100 series highways. The 'Do Nothing' alternative is not acceptable since it does not address the objective of the Project

Upgrade the Existing Alignment - Sections of highway that do not have adjacent development, or where development is limited and well set back from the roadway, can often be upgraded as controlled access highways by constructing parallel service roads. It is also often practical in those situations to acquire additional right-of-way to allow for construction of a four lane divided highway. Because of the amount and proximity of roadside development in the study area, it is not possible to upgrade the existing alignment to provide a four lane divided controlled access highway, without considerable cost and disruption to the public.

Other Modes - Air, rail, and bus are other efficient modes for long distance passenger travel. Air travel is prohibitively expensive for most travellers and has limited servicing capabilities with regards to origins and destinations. There has not been passenger rail service between Truro and Cape Breton for many years and transit or bus service there is limited. Although rail is often a realistic alternative to trucking for long distance goods movement, during the past 25 years there has been a shift from rail to trucking that is not expected to change in the near future. Other modes of transportation are not considered as effective or feasible alternatives to the proposed Project.

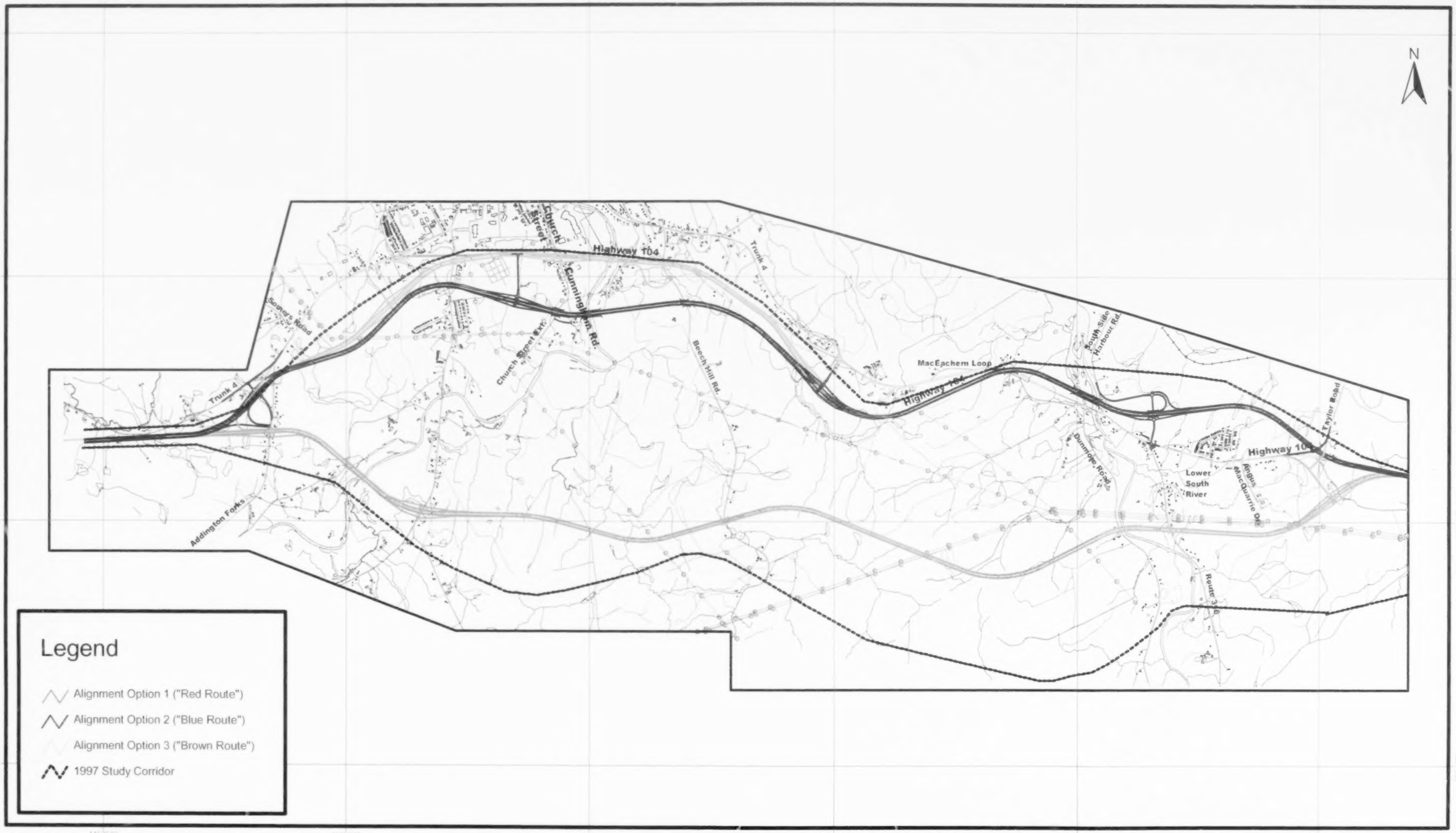
2.7.2 Other Methods for Carrying Out the Proposed Project

Alternative means of carrying out the Project are defined as methods of similar technical character or methods that are functionally the same (CEA Agency 1994). During the planning process of this Project, a number of alternative means for carrying out the Project have been considered.

In the winter of 1996/97, NSTPW conducted a preliminary environmental screening to identify and review potential environmental impacts associated with the upgrading of the existing Highway 104 in Antigonish. The NSTPW screening utilized the Highway Environmental Database Study (NSDOTC 1991) process that includes a review of 13 environmental categories comprising 63 potential environmental constraints (NSTPW 1997a). Information for an environmental screening study is based on existing recorded information and staff knowledge from various government departments, municipalities, organizations, businesses, interest groups and the general public.

Following completion of the environmental screening for highways, a single broad corridor along and south of the existing Highway 104 was identified for presentation at the first public open house. This corridor incorporated ten exclusion zones identified through the completion of the screening. The corridor, between approximately 1 and 3 km wide, extended west to east from approximately 1 km west of Addington Forks Road to just east of Taylor Road (Figure 2.2).

The northern boundary of the corridor followed the existing Highway 104 until it descended approximately 300 m south of the highway just west of Trunk 4 from Antigonish where the boundary continued south of the existing 104 as far as Dunn's Loop, where it crossed again and remained less than 1 km north of the highway to just past Taylor Road where it rejoined the existing alignment.



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Jacques Whitford

NOVA SCOTIA
Transportation and Public Works

SCALE: 1 : 37 500
Date: 9/01/2004
Drawn By: GM
Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Alternatives Alignment Options

.5 0 .5 1.0 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.
NSD16949
FIGURE 2.2

The southern boundary of the corridor presented at the open house paralleled the northern boundary forming a narrow corridor of less than a kilometre from Addington Forks Road to just east of the West River Road where it expanded to form a corridor of between one to three kilometres as far west as just past Taylor Road where it ended.

Public consultation concerning the Project was initiated in May, 1997 with an open house public meeting held at the Saint Francis Xavier University in Antigonish. Over 300 area residents attended this meeting where the preliminary environmental screening results were presented and public opinions were solicited relating to broad corridors and potential access locations being considered by NSTPW.

The Preliminary Environmental Screening (NSTPW 1997a) revealed concern for constraints that either indicated the need for further study or the need to be aware of the constraints when locating the proposed highway alignment within the corridor. Several constraints, as listed below, were either noted in the screening process or were observed by members of the public.

- Mineral resources, sand and gravel deposits, karst terrain and highly erodible soils were noted as geological constraints. Potential karst development was identified as the most significant geological constraint.
- Components of the terrestrial environment that presented constraints included eagle and osprey nesting sites, a potential old growth hardwood stand, and the Dagger Woods Marsh (noted as a managed wetland and wildlife area). It is noted that following the selection of the current proposed alignment, the Dagger Woods Marsh was no longer included in the study area. A survey was recommended to determine the presence and location of rare plants and animals believed to exist in the area. The need to minimize impacts on wetlands was noted and avoidance, if possible, was recommended.
- In the aquatic resources component, fifteen streams were identified, five of which were considered to be major salmon streams, with an additional ten being identified as trout streams. It was noted that the West River and Brierly Brook were subject to salmonid restoration programs. Recommendations included adherence to work progression clauses, avoidance of sensitive areas and timely implementation of sediment and erosion control measures. Flood plains along the West and South Rivers were also identified as a potential constraint. Flood risk mapping within the boundaries of the study area showed flood north of the proposed alignment in the area between the Cunningham Road and West River.
- The South River estuary salt marsh was identified as a constraint under marine environment.
- Agricultural lands and one fox farm were noted as constraints under the agricultural land section while managed woodlots were noted under the Forestry component.

- Under the land/water use section the constraints identified included proposed residential developments, the Beech Hill Landfill site, kaolin clay and limestone mineral claims and navigable waters (South and West Rivers). It is noted that the landfill is outside the study area and that no indications of mineral claim development were given during discussions with the municipal planners.
- Recreation constraints identified by the Municipality were ball fields and snow mobile trails. The use of the West River as a canoe route was noted by a Fisheries and Oceans representative, however the route does not appear in provincial sources of data.
- Municipal wells located in Lower South River were identified as constraints under the water supply component.
- Utilities typical of municipal areas including power transmission and distribution lines, telephone lines, a telecommunication tower and water and sewer lines and the associated treatment plant in Lower South River were identified as constraints.
- Two cemeteries were noted as constraints, however, during field reconnaissance it was noted that these were outside the study area.

Using the information obtained through the environmental screening and public consultation, three potential alignments (Figure 2.2) were identified by NSTPW and AEC. A second open house meeting was held at the Saint Andrew Junior High School in Antigonish in May 1998 to present the options and to obtain public input regarding these and potential access locations. Prior to the consultation, efforts were made to contact, either by telephone or mail, all property owners directly affected by any of the three options. Information flyers consisting of a fact sheet and a small plan were sent to most homes and businesses in Antigonish County and advertisements were placed in the local paper. Over 700 residents of the area attended and 612 completed questionnaires were submitted (NSTPW 2001a). There was varied support for the three routes and interchange locations.

The three routes presented at the May 1998 open house were initially referred to as Options One, Two and Three and ultimately came to be known as the Red, Blue and Brown alignments, respectively. Option One was to replace the existing highway near the town of Antigonish while Option Two was up to 600 m south of the existing highway. The two alignments joined in the vicinity of Trunk 4. Option Three was located 2-3 km south of the existing Highway 104. An information flyer distributed at the meeting described the three options along with their advantages and disadvantages.

The red alignment (Option One) replaced a portion of the existing Highway 104 and maintained the visibility and access to local businesses, however it also entailed some damage to property and disruption of traffic flow during construction. The blue alignment (Option Two), quite similar to the red, was located between 300 and 600 m south of the existing highway, reduced property damage and minimized traffic disruption; however its proximal location to residential areas, potential impacts to farmland and reduced visibility to the town were considered negative features. The brown alignment (Option Three), located 2-3 km south of the existing Highway 104, provided for total separation of local and through traffic, minimized disruption of residential areas and significantly reduced property acquisition costs; however it presented the most significant negative economic impact on the community.

A debriefing of staff following the meeting, subsequent correspondence received by NSTPW, and the local newspaper indicated strong support for the Blue and Brown routes, conflicting with the survey analysis, which identified the Red alignment as the preferred route. Further investigations including a safety review in 1999 (Beasy Nicoll Engineering Ltd. 1999), a peer review in 2000 (Scott and De Chiara 2000) and the South River Impact Study (Neill and Gunter Ltd. 2001) were undertaken. The Blue Route was ultimately selected based on an overall evaluation of constraints.

The final alignment proposed for EA registration of the Project was presented at a third open house meeting held in May 2001. Approximately 200 people attended this session with completed comment sheets handed in. Analysis of the comment sheets revealed 52% of respondents supported the Project, while 15% did not support the Project. Another 22% of respondents did not oppose the Project but had concerns over certain aspects of the proposed work.

In addition to alignment alternatives, other alternative means of carrying out the proposed Project may include buffer zones, alternative wetland and watercourse crossing methods/structures such as bridges, underpasses, and wildlife corridors (refer to Section 2.4.3). Specific alternatives and preferred options are discussed further in relevant sections in this report.

3.0 ENVIRONMENTAL SETTING

This section provides an overview of the existing biophysical, socioeconomic and regulatory environment in the study area. Table C1 (Appendix C) summarizes existing biophysical and socioeconomic characteristics, and provides relevant regulatory information for those constraints. Sub-categories in Table CB1 have been derived from a series of constraints specified in the Highway Environmental Database Study (NSDOTC 1991), and have been supplemented with additional categories according to the specific requirements of this study. A detailed description of relevant aspects of the existing environment is provided for Valued Environmental Components (VECs) and Valued Socioeconomic Components (VSCs) in Sections 5.0 and 6.0, respectively.

3.1 Biophysical Environment

The study area is located near the Town of Antigonish and community of Lower South River, extending from Addington Forks Road easterly approximately 15 km to Taylor Road. The proposed Highway 104 alignment is located within the Antigonish Basin. The alignment follows within 600 m of the current Highway 104 alignment at elevations ranging from sea level at Lower South River, to just over 50 m above sea level, and generally drains northwards through streams and watercourses into Antigonish Harbour (Figure 1.1).

The alignment is underlain by two geological formations: the Mabou and Windsor Groups. While there are no rock types associated with acid drainage problems in the area, a portion of the alignment may pass over Karst terrain near Lower South River. The Windsor Group presents potential for Karst development. Windsor Group rocks occurring along the alignment consist of the Hood Island Formation, which underlies approximately seven kilometres of the route. The rocks in this formation consist of red siltstone and sandstone with intercalated marine limestone and dolostone and minor gypsum.

Throughout Nova Scotia the formation of Karst Topography is typically associated with areas underlain by Carboniferous rocks of the Windsor Group which contain the rock types noted above. Geological mapping by R. C. Boehner and P. S. Giles, (1993) indicates minimal occurrence of soluble rock and limited outcropping of other sedimentary rock types along the proposed highway alignment.

Overburden consists of glacial deposits derived from the underlying and 'up-ice' bedrock units, and soil which is derived from the parent glacial tills. This till and glaciofluvial material was laid down by major ice sheets advancing across the area from northwest to southeast. Based on available geological mapping, two types of glacial overburden deposits are identified along the proposed alignment. The overburden can be subdivided into clay till and sand/gravel glaciofluvial deposits.

The proposed alignment passes through the Carboniferous Lowlands biophysical theme region (Davis and Browne 1996). The vegetation of this region is dominated by coniferous tree species the most abundant of which are black spruce (*Picea mariana*), jack pine (*Pinus banksiana*) white spruce (*Picea glauca*), red spruce (*Picea rubens*) and by red maple (*Acer rubrum*), a shade intolerant hardwood species. Hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*) are also not uncommon. Hemlock may occur in pure stands throughout, while extensive boggy areas are typically dominated by black spruce and tamarack (*Larix laricina*). American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) are found on slopes near the larger streams. Much of the area is farmed and old fields generally re-colonize in alders (*Alnus incana*) followed by white spruce (Davis and Browne 1996).

Terrestrial field studies conducted for the Project revealed the habitats in the study area to be relatively diverse and somewhat fragmented by secondary roads, woods roads, agricultural land, recent clear-cuts, and residential developments. Habitats present include: mixedwood, hardwood and softwood forest ranging in age from immature to mature, recent clear-cuts, treed swamps, tall shrub dominated swamps, low shrub dominated swamps, bogs, marshes, riparian habitats, abandoned pasture, active agricultural land, and residential areas. Forested habitats along the proposed route are generally young, typically less than 30 years old. Most of the residual older stands in the area visible on the most recent aerial photography, have been recently harvested. Forests along the route are composed largely of species characteristic of the early stages of forest succession in Nova Scotia including trembling aspen (*Populus tremuloides*), red maple (*Acer rubrum*), white birch (*Betula papyrifera*), grey birch (*Betula populifolia*), white spruce, and balsam fir (*Abies balsamea*). No old growth forest, mature climax or climax dominated forests are present along the proposed route.

Twelve rare and uncommon plant species were found along the route during the field survey. One of these species, coffee-tinker's weed (*Triosteum aurantiacum*), is considered to be at risk in Nova Scotia (NSDNR 2002a). Three other species are considered to be sensitive to human activities in Nova Scotia, including Canada lily (*Lilium canadense*), wood nettle (*Laportea canadensis*) and black ash (*Fraxinus nigra*). All of these species, with the exception of black ash, were found in riparian habitat at the West River crossing site. The black ash was found in a recent clear-cut near 12 + 500. All of these species were found within the highway RoW. The remaining eight species are classed as uncommon in Nova Scotia (ACCDC 2002a) and their populations are considered to be secure in Nova Scotia (2002a). These include large purple-fringed orchid (*Platanthera grandiflora*), purple milkweed (*Asclepias incarnata*), hornwort (*Ceratophyllum demersum*), bloodroot (*Sanguinaria canadensis*), water loosestrife (*Lysimachia thyrsiflora*), pennsylvania smartweed (*Polygonum pensylvanicum*), marsh mermaid-weed (*Proserpinaca palustris* var. *creba*), and readhead grass (*Potamogeton richardsonii*). These species were found either in wetland habitats or riparian habitats at various locations along the route.

Twenty-one wetlands are found within the RoW of the proposed highway. One of the wetlands (Wetland 5) was infilled prior to the onset of the field surveys and was not evaluated. Wetland evaluations were conducted on the remaining wetlands. The wetland functional analyses completed in August 2002 revealed that five wetlands (Wetlands 1, 2, 10, 15, and 17) provided habitat for uncommon plant species. Four other wetlands (Wetlands 1, 6, 11, and 12) by virtue of their relatively large size were considered to have moderate value in regards to surface water flow regulation including augmentation of stream flow during low water periods and attenuation of flooding.

No rare herpetile species were identified within the study area however habitat suitable to the wood turtle, (*Glyptemys inscuplta*) listed by NSDNR as a sensitive species, was noted along the proposed alignment. No rare or sensitive mammal species were identified within the study area (refer to Section 5.5).

One provincially rare bird species, Nelson's Sharp-tailed Sparrow (*Ammodramus nelsoni*) was found near the proposed highway in the tidal fresh marsh habitat on the South River. The Nova Scotia population of Nelson's Sharp-tailed Sparrow is considered to be sensitive to human activities or natural occurrences (NSDNR 2002a). Four uncommon species were also found along the route including Merlin (*Falco columbius*), Boreal Chickadee (*Parus hudsonicus*), Black-billed Cuckoo (*Coccyzus erythropthalmus*), and Bobolink (*Dolichonyx oryzivorus*). The Nova Scotia Bobolink population is considered to be sensitive to human activities; however, the populations of the other three species are considered to be secure (NSDNR 2002a). Bobolinks were heard near the West River and South River outside of the proposed RoW. Other than Merlin, Osprey and Bald Eagle were the only raptor species believed to breed near the proposed highway RoW. Three Osprey nests have been recorded within 400 m of the RoW. The nearest osprey nest is located approximately 200 m from the RoW. The nearest Bald Eagle nest is an inactive nest, that is located approximately 430 m from the proposed highway.

Thirty watercourse crossings were identified using 1:10,000 mapping, however field reconnaissance identified only 16 crossings. Fish were observed in three brooks. Atlantic Salmon (*Salmo salar*), banded killifish (*Fundulus diaphanus*), white sucker (*Catostomus commersoni)*, northern redbelly dace (*Chrosomus eos)*, creek chub (*Semotilus atromaculatus)*, three-spine sticklebacks (*Gasterosteus aculeatus*) and nine-spine sticklebacks (*Pungitius pungitius*) were the only fish caught or observed during the fish and fish habitat survey conducted for the Project. However, other fish species are reported to occur in some of the surveyed watercourses where they may be present for at least part of the year. Descriptions of fish and fish habitat are presented in Section 5.3 and Appendix D.

A hydrological study was completed for the Project (refer to Appendix B) on all watercourses to be crossed by the proposed alignment. The South River was evaluated in a separate study (Appendix E) conducted at the proposed crossing location. As discussed in Section 5.3, DFO identified watercourse crossings with significant fish habitat during the environmental screening and *Federal Coordination Regulations* processes.

These crossings are noted as follows with chainage shown in brackets):

- Brierly Brook, although not directly crossed by the alignment may be affected by crossings of its tributaries located at (0+100 and 0+275);
- West River (5+700);
- Unnamed tributary to Antigonish Harbour Station (8+150);and
- South River (11+350).

None of the crossings showed signs of active ice movement (ice scour, erosion, scarring, significant debris in channel).

Further detail on the biophysical environment in the study area is provided in Section 5.0, Environmental Effects Assessment.

3.2 Socioeconomic Environment

Antigonish is about 200 km from Halifax and is situated in the northeastern part of Nova Scotia with a total area of 1,463 km^2 or 2.8 % of the province's land mass. It is divided into two jurisdictions - the Town and County of Antigonish. The Town has a population of 4,754 based on 2001 data over a total land area of 5 km^2. The County has a population of 19,578 and a total area of 1,458 km^{2}The combined population of the Town and County is 24,332.

According to the Antigonish Regional Development Authority (ARDA), the region's main economic advantage is the stability provided by the educational and health services in the Town. The region enjoys employment opportunities for professionals and non-professionals in St. Martha's Regional Hospital (300 employees) and Saint Francis Xavier (St. FX) University (500 employees). In general, the largest employers are public organizations, including St. FX, the hospital and the school board (ARDA 2002).

Employment by major industry classification includes: 74 % in service industries; 14 % in manufacturing and construction industries; and 12 % in agriculture and other resource-based industries. Based on 1996 data, retail trade employed most of the work force (15%) followed by educational services (12%) and health (12%) (ARDA 2002).

There is one serviced industrial park located east of the Town with direct access to Trans-Canada Highway 104. The Antigonish County Industrial Park consists of 41 hectares (101 acres) of land, serviced by a potable water distribution system, storm and sanitary sewers, and fire hydrants. Industries important to Antigonish include fishing, forestry, dairy and tourism (ARDA 2002).

In 1999, Antigonish contributed 1.6 % ($10 million) to the total landed value of fisheries in Nova Scotia. Lobster is the main fishery commodity in the region, followed by bluefin tuna, winter flounder, white hake, and American plaice (Nova Scotia Department of Agriculture and Fisheries (NSDAF) 2000). Based on 1997 data, there are 11 sawmills in Antigonish. Sawn fibre production (60,000 m^3) was 2% of total provincial harvest while roundwood yield (5400 m^3) was only 0.2%. Antigonish contributes 10% to Nova Scotia's total dairy production. Scotsburn Cooperative Dairy derives 25% of its milk from the Antigonish and Guysborough Counties. A total of 20.2% of the land area of Antigonish is farmland accounting for 6.9% of all agricultural farms in the province. About 33% of this land is for beef cattle, 22% for dairy cattle, 21% for Christmas trees, and 18% for other crops. There are a total of 247 farms in the County with total value of production of $19 million, which account for about 5% of Nova Scotia's gross farm income.

The Antigonish area is located along the Northumberland Strait and may be accessed by the scenic highway the Sunrise Trail. The Antigonish-Eastern Shore tourism area covers Antigonish County, Guysborough County, and the portion of Halifax County east of a line running from the mouth of the Little Salmon River at Cole Harbour to Gays River. Antigonish is the only community in that area that is located on a 100 series highway, with all other communities located on secondary highways.

Tourism and recreation areas in Antigonish include: supervised beaches in Bayfield and Pomquet; provincial parks; trails such as canoe waterways, coastal water trails, sea kayak routes, snowmobile, and the Trans Canada Trail; and nature sites including the Antigonish Harbour Wildlife Management Area, Arisaig Sea Cliffs, and Pomquet Beach Region. Another tourism and recreation area of interest is the newly built Keating Millennium Centre located in the Town of Antigonish, owned by St. FX University. It houses an IT training centre, two ice surfaces, convention facilities, and various fitness and water-related wellness activities. The Town also hosts the Antigonish Highland Games every July featuring Scottish traditions including language, music, dances and songs, along with feats of strength and excellence.

There are no registered archaeological sites within the study area, however, four heritage features were identified within the study area.

Further detail on the socioeconomic environment in the study area is provided in Section 6.0, Socioeconomic Effects Assessment.

3.3 Regulatory Environment

This Project is subject to numerous federal and provincial laws, regulations, and guidelines. NSTPW is required to register this Project as a Class II undertaking pursuant to the Nova Scotia *Environment Act* and *Environmental Assessment Regulations*. The Project is also subject to approval under the *CEAA* as a screening level assessment. The following provides context for the regulatory requirements of the Project. While this is not intended to be an exhaustive list of pertinent federal and provincial legislation and policies, it does provide an overview of key regulatory considerations for Project planning and implementation. Further detail on applicable legislation and guidelines is provided in Appendices B and E, and throughout the Report, with regard to specific activities (*e.g.*, blasting and acid generating rock) and VECs/VSCs.

3.3.1 Federal Legislation

Eligibility for federal funding for this Project is dependent on approval of the proposed Project under *CEAA*. In September 2001, the project description was distributed to Transport Canada, Environment Canada and DFO in accordance with the requirements of the *Federal Coordination Regulations (FCR)*. In the event that this Project is considered for federal funding, Transport Canada would require an environmental screening report under *CEAA*. Correspondence in the course of the *FCR* process (Appendix F) have indicated that Transport Canada will act as a Responsible Authority (RA) under *CEAA*. Some watercourses crossed by the alignment, in particular the South and West Rivers and possibly others, are likely to require approval under the *Navigable Waters Protection Act*, administered by Transport Canada. Although Environment Canada is not likely to have any power, duty or function in relation to the proposed Project that would trigger *CEAA*, it is in possession of expert and specialist information and is therefore recognized as an expert department for this environmental assessment. DFO is an RA since *Fisheries Act* Authorization will likely be required for one or more of the proposed culvert installations that may result in the harmful alteration, disruption or destruction (HADD) of fish habitat. DFO also has relevant expertise regarding the assessment.

DFO has developed the *Policy for the Management of Fish Habitat* (1986), which applies to all projects and activities, in or near water, that could alter, disrupt, or destroy fish habitats by chemical, physical, or biological means. The guiding principle of this policy is to achieve no net loss of the productive capacity of fish habitats. The *Policy for the Management of Fish Habitat* is regulated by the following sections of the *Fisheries Act:* Section 20, 21, 22, 30, 32, 35, 37, 40 and 43, which are administered by DFO. Under the terms of a Memorandum of Understanding with Environment Canada, the Minister of Fisheries and Oceans continues to be legally responsible to Parliament for all sections of the *Fisheries Act*. However, for Sections 36 to 42, Environment Canada administers those aspects dealing with the control of pollutants affecting fish. DFO will co-operate with Environment Canada in the establishment of federal priorities for the protection of fish and their habitats from deleterious substances.

With respect to culvert installations and extensions, the *Fisheries Act* (Section 20) requires safe fish passage in all watercourses that bear fish. This is administered by DFO in close collaboration with NSDEL through the Water Approval process (formerly Watercourse Alteration Permit) under the provincial *Designated Activities Regulation*. This application process applies to new culvert installations and existing culverts which may require extensions and upgrading. DFO encourages all owners or occupiers to inspect existing culverts and upgrade these fishways, if necessary, to ensure adequate fish passage. Upgrades and new culvert installations will be completed as per the criteria presented in Conrad and Jansen (1994), or updates.

Under Section five of the *Navigable Waters Protection Act*, construction of works for activities below the high water mark in navigable waters must be approved in advance by Transport Canada. Examples of potential applicable activities include excavation, dredging, bridges, culvert installation, and construction of retaining walls. Under Sections 21 and 22, the *Act* prohibits the discharge of any waste or other material that may impair navigation in these waters.

Migratory birds are protected under the *Migratory Birds Convention Act* and Regulations which states that, "no person shall disturb, destroy or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird" without a permit. Section 35 of the *Migratory Birds Regulations* prohibits the deposit of oil, oil wastes or other substances harmful to migratory birds in any waters or any area frequented by migratory birds.

Other relevant federal legislation includes *CEPA, 1999* and the new *Species at Risk Act* (SARA). *CEPA, 1999* relates to the management of toxic substances (*e.g.*, road salt) and to the development of environmental quality objectives and guidelines. *SARA* is designed to protect plant and animal species at risk nationally and their critical habitat. *SARA* builds on existing laws and agreements and complements provincial initiatives to protect species at risk. It is noted that prior to the enactment of *SARA*, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessments were the basis for the endangered species list. Under the new act, assessments of species at risk in Canada previously determined by COSEWIC will continue, however, COSEWIC assessments will now be published in the *SARA* public registry and the legal designation of these species will be achieved through the Governor-in-Council. Refer to Section 5.9 for more information on the specific implications of *SARA* to this Project.

3.3.2 Provincial Legislation

NSTPW is required to register this project as a Class II undertaking pursuant to the Nova Scotia *Environment Act* and *Environmental Assessment Regulations*.

The *Environment Act* promotes protection and prudent use of the environment. All provincial and federal departments, agencies, boards and commissions and the general public are subject to prosecution, ministerial orders and other remedies under the *Act*. Twenty-two sets of regulations have been passed under the *Environment Act* to help deal with the practical application of the *Act*. Regulations most relevant to this Project include: *Activities Designation Regulations*; *Environmental Assessment Regulations*; *Air Quality Regulations*; *Dangerous Goods Management Regulations*; *Solid Waste-Resource Management Regulations*; and *Sulphide Bearing Material Regulations*.

Under the *Activities Designation Regulations*, a Water Approval is required for watercourse alteration activities proposed during the construction phase (*e.g.*, culvert installation). Also requiring approval under the *Activities Designation Regulations* is the disposal of sulphide bearing material. The *Sulphide Bearing*

Material Regulations contain provisions for sampling, criteria for site excavation and requirements for disposal of sulphide bearing materials (*i.e.*, acid producing bedrock).

In addition to the *Environment Act* and Regulations, other relevant provincial laws include, but are not limited to: the *Dangerous Goods Transportation Act*; *Occupational Health and Safety Act; Special Places Protection Act*; *Endangered Species Act* and *Wildlife Act*.

All Project work will be conducted in accordance with applicable provincial legislation.

3.3.3 Policies and Guidelines

The construction of the proposed alignment will follow specifications prepared by NSTPW, including Highway Construction and Maintenance Standard Specifications (NSTPW 1997 and revisions) and Approval Process for Pits Containing Slates (NSDOTC 1990), and by NSDEL, including the Pit and Quarry Guidelines (NSDOE 1999), and the Erosion and Sedimentation Control Handbook for Construction Sites (NSDOE 1988). Other relevant NSDEL guidelines and specifications include the Guideline for Environmental Noise Measurement and Assessment (NSDOE 1989) and the Guidelines for Management of Contaminated Sites in Nova Scotia (NSDOE 1996).

Joint provincial-federal publications include Guidelines for Development on Slates (NSDOE and Environment Canada 1991), and Environmental Construction Practice Specifications (Fisheries and Oceans Canada *et al.* 1981). Relevant federal guidelines include Environmental Code of Good Practice for Highways and Railways (Storgaard and Associates 1979).

In Nova Scotia, wetlands are protected by the Wetlands Directive (NSDOE 1995a). Any loss of wetland requires a wetland evaluation to establish the value of the wetland in relation to the merits of the development. Wetlands under 2 ha in size are evaluated using the NSDEL 10 step wetland evaluation procedure. Wetlands larger than 2 ha are evaluated using the North American Wetland Conservation Council wetland evaluation procedure. The Federal Policy on Wetland Conservation (1992) promotes wetland conservation, and specifically, no net loss of wetland functions on federal lands and waters.

The Guidelines for Management of Contaminated Sites in Nova Scotia (NSDOE 1996) describe the process to manage land that has potential for unacceptable impacts or risks associated with the presence of contaminants (refer to Section 2.4.14).

Project work will adhere to all applicable policies and guidelines.

4.0 ENVIRONMENTAL ASSESSMENT METHODOLOGY

4.1 Overview and Approach

The environmental assessment methodology for the Project has been developed to satisfy regulatory requirements for a screening level assessment pursuant to the *CEAA* and an environmental assessment for a Class II Undertaking under the Nova Scotia *Environmental Assessment Regulations*.

The approach and methodology used are based largely on the work of Beanlands and Duinker (1983), the Canadian Environmental Assessment Agency (1994, 1997, 1999a,b) and Barnes *et al* (2000), as well as the study team's expertise in conducting environmental assessments. The approach and methods used have proven very effective for assessments conducted under federal, provincial, joint federal-provincial and multi-party processes, as well as for environmental assessments in various jurisdictions throughout the world. The assessment focusses on environmental components of greatest concern (to potentially affected parties).

Assessing all of the potential issues associated with a proposed undertaking is impractical, if not impossible (Beanlands and Duinker 1983). It is therefore generally acknowledged that an environmental assessment should focus on those components of the environment that are valued by society and/or that serve as indicators of environmental change. These components are known as VECs and VSCs. The environmental assessment for the Project evaluates the potential effects, including cumulative effects, of each Project phase (construction and operation) with regard to each VEC or VSC. The cumulative effects assessment, including details on methodology and approach is included in Section 8.

4.2 Issues Scoping and Selection of Valued Environmental and Socioeconomic Components

A scoping exercise was conducted by the study team to identify an appropriate list of VECs and VSCs. This exercise included a review of: the Environmental Assessment Registration Document for the Highway 104 at Antigonish (NSTPW 2001a); Terms of Reference as required by the *Environment Act* (NSDEL 2002a); and Comments Submitted on the Proposed Terms of Reference and Environmental Assessment Registration Document (NSDEL 2002b). The latter included comments from provincial and federal regulatory agencies, as well as public comments. Preliminary research, stakeholder consultation, field investigations and the study team's professional judgement were also used in the issues scoping process.

Table 4.1 lists Project stakeholders contacted by the study team during the scoping process.

Table 4.1 Stakeholders Contacted by the Study Team for the Environmental Assessment Report

Name	Title	Organization
Michael Julien	Chief	Afton First Nation
Jocelyn Gillis	Curator	Antigonish Heritage Museum
Aaron Applin	Technical Intern	Antigonish Regional Development Authority
Don Cameron	Development Officer	Antigonish Regional Development Authority
Veronica Gillies	Development Officer	Antigonish Regional Development Authority
Cameron McKenzie	Chairman	Antigonish Regional Development Authority
John Parker	Executive Director	Antigonish Regional Development Authority
John Tramble	Member of the Board	Antigonish Regional Development Authority
Stefen Gerriets	Data Manager	Atlantic Canada Conservation Data Centre
Ken Simms	Owner	Casket Publishing
Dorothy Westmon	Reporter	Casket Publishing
Danielle Goth	Habitat Management Officer	Department of Fisheries and Oceans Canada
Inez Grant	N/A	Landowner
Elizabeth O'Neill	N/A	Landowner
J. Oostyogels	N/A	Landowner
George Lerikos	Owner	Lobster Treat Restaurant
Roderick Ian MacPherson	Owner	MacPherson's New To You Furniture
David Miller	Owner	McDonald's Restaurant
Alan J. Bond	Municipal Clerk/Treasurer	Municipality of the County of Antigonish
Kemp MacDonald	Municipal Planner/Development Officer	Municipality of the County of Antigonish
Mike O'Leary	Director of Public Works	Municipality of the County of Antigonish
Ken Proctor	Engineer	Municipality of the Town of Antigonish
Mark Pulsifer	Regional Biologist	Nova Scotia Department of Natural Resources
Donald Carter	Construction Manager	Nova Scotia Department of Transportation and Public Works
Phil Corkum	Manager, Highway Planning and Design	Nova Scotia Department of Transportation and Public Works
Mike Croft	Engineer, Highway Planning and Design	Nova Scotia Department of Transportation and Public Works
Lester Hanley	Senior Traffic Engineering Technician	Nova Scotia Department of Transportation and Public Works
Paul Smith	Road Safety Engineer	Nova Scotia Department of Transportation and Public Works
Andrew Hebda	Curator of Zoology	Nova Scotia Museum
Marian Munro	Curator of Botany	Nova Scotia Museum
Robert Oglive	Curator, Special Places	Nova Scotia Museum
Stephen Powell	Assistant Curator, Archaeology	Nova Scotia Museum
John Gilhen	Curator of Ichthyology and Herpetology (Retired)	Nova Scotia Museum (formerly of)
Minke Inglis	Member	Profile Antigonish
Paul MacLean	Chair	Profile Antigonish
Brian Segull	Owner	Redgull Incorporated
Fraser Dunn	Local Historian	Resident of Antigonish
Heather Magotiaux	Advancement	St. Francis Xavier University
Ron Bantjes	Chair, Department of Sociology	St. Francis Xavier University
Tiiu Poder	Executive Director	St. Francis Xavier University
David Fullerton	Small Business Training and Development Manager	St. Francis Xavier University - Enterprise Development Centre
Mary McLellan	Town Councillor	Town of Antigonish
Gary Cusack	Owner	Welcome Inns

Table 4.2 summarizes the issues identified during the scoping process and their respective sections, where they are addressed in the EA Report.

Table 4.2 Issues Identified During the Scoping Process

Issue Identified	Where Addressed in EA Report
Atmospheric conditions	Sections 5.1, 9.0
Potential for micro-climate modifications	Section 9
Blasting effects	Sections 2.4.6, 5.2.1, 5.2.8, 5.2.7, 5.3.4
Acid generating rock and impact of acidic runoff	Sections 2.4.12, 5.2.4, 5.3.4
Karst topography	Sections 2.4.13
Fish habitat evaluation	Section 5.3
Impacts on wetlands	Section 5.8
Impacts on fauna	Sections 5.4, 5.5, 5.6, 5.8
Impacts on flora	Sections 5.7, 5.8
Impacts associated with contaminated soils and runoff	Sections 2.4.14, 5.2.2
Noise impacts (including human and wildlife)	Section 5.1
Groundwater impacts	Section 5.2
Significant wildlife habitat, management areas and corridors	Sections 5.4, 5.5, 5.6, 5.8
Local economy	Section 6.1
Landowner access	Sections 6.2, 6.4
Impacts on land use	Section 6.2
First Nations current or historical land use	Section 6.2, 6.3
Future development options	Section 6.2
Impacts on residential property values	Section 6.1
Archaeological and palaeontological sites	Section 6.3
Effects on safety	Section 6.4
Impacts on transportation	Section 6.4
Alternative transportation infrastructure	Section 2.7
Fragmentation of landholdings	Section 6.2

Based on a review of issues identified (Table 4.2) and the professional judgement of the study team, the following VECs/VSCs have been identified for the purpose of this EA Report (Table 4.3).

Table 4.3 Identified VECs and VSCs

VECs	VSCs
• Atmospheric Resources	• Local Economy
• Groundwater Resources	• Land Use
• Fish and Fish Habitat	• Archaeological and Heritage Resources
• Rare Herpetiles	• Transportation Infrastructure
• Rare Mammals and Critical Habitat	
• Rare and Sensitive Birds	
• Rare Plants and Plant Communities	
• Wetlands	

Table 4.4 provides the rationale for the selection of the chosen VECs and VSCs. Public/stakeholder concerns included comments submitted during the open house public meetings, public review of the EA Registration document (NSTPW 2001a) and Terms of Reference (NSDEL 2002a), and through individual landowner/stakeholder consultation by JW. Regulatory considerations include those raised by government regulatory officials and relevant legislation. Professional judgement was based on the opinion and experience of the study team.

Table 4.4 Valued Environmental Components (VECs) and Valued Socioeconomic Components (VSCs) and Selection Rationale

VEC/VSC	Terms of Reference	Public/Stakeholder Concerns	Regulatory Considerations	Professional Judgement	Where VEC/VSC is addressed in EA Report
Atmospheric Resources	✓		✓	✓	Section 5.1
Groundwater Resources	✓		✓	✓	Section 5.2
Fish and Fish Habitat	✓	✓	✓	✓	Section 5.3
Rare Herpetiles	✓		✓	✓	Section 5.4
Rare Mammals and Critical Habitat	✓	✓	✓	✓	Section 5.5
Rare and Sensitive Birds	✓	✓	✓	✓	Section 5.6
Rare Plants and Plant Communities	✓		✓	✓	Section 5.7
Wetlands	✓		✓	✓	Section 5.8
Local Economy	✓	✓		✓	Section 6.1
Land Use	✓	✓		✓	Section 6.2
Archaeological and Heritage Resources	✓		✓	✓	Section 6.3
Transportation Infrastructure	✓	✓		✓	Section 6.4

4.3 Potential Interactions Between Project Activities and Valued Environmental and Socioeconomic Components

Tables 4.5 and 4.6 summarise the potential interactions between Project activities and the selected VECs and VSCs, respectively. The specific nature and extent of these interactions with each VEC/VSC are discussed and evaluated in the biophysical and socioeconomic effects assessments (Sections 5.0 and 6.0).

Table 4.5 Potential Interactions Between Project Related Activities and Valued Environmental Components

Project Activities	Atmospheric Resources	Groundwater Resources	Fish and Fish Habitat	Wetlands	Rare Herpetiles	Rare Mammals and Critical Habitat	Rare and Sensitive Birds	Rare Plants and Plant Communities	Potential Effects
CONSTRUCTION									
Site Preparation: surveying; clearing; grubbing	✓		✓	✓	✓	✓	✓	✓	Removal of vegetation leading to soil erosion and runoff; damage to streambanks and beds; loss and fragmentation of terrestrial habitat; disturbance of wildlife; air, noise, and dust emissions from construction equipment
Roadbed Preparation: blasting; ripping; placement of fill; grading	✓	✓	✓	✓	✓	✓	✓	✓	Soil compaction and rutting; damage to streambanks and beds; runoff; disturbance of wildlife; air, noise and dust emissions from construction equipment; and dust and noise emissions and groundwater disturbance from blasting
Watercourse Crossing: site preparation; stream diversion; culvert installation; restoration	✓		✓	✓	✓	✓	✓	✓	Habitat/watercourse disruption and/or degradation; release of contaminants; disturbance of wildlife; erosion and sedimentation; fish mortality; stormwater runoff; soil mixing and compaction; air and noise emissions from construction equipment

Table 4.5 Potential Interactions Between Project Related Activities and Valued Environmental Components

Project Activities	Atmospheric Resources	Groundwater Resources	Fish and Fish Habitat	Wetlands	Rare Herpetiles	Rare Mammals and Critical Habitat	Rare and Sensitive Birds	Rare Plants and Plant Communities	Potential Effects
Surfacing and Finishing Activities: paving; line painting; guard rail installation	✓					✓	✓		Air and noise emissions from construction equipment; disturbance of wildlife;
OPERATION AND MAINTENANCE									
Road and RoW maintenance: asphalt repair; repainting; shoulder regrading; mowing	✓		✓	✓	✓	✓	✓	✓	Air and noise emissions from equipment; disturbance to existing vegetation; erosion from shoulder regrading
Winter maintenance: salt application; snow plowing		✓	✓	✓	✓	✓	✓	✓	Surface and groundwater contamination; vegetation disturbance
Highway operation: presence of RoW; vehicular traffic	✓				✓	✓	✓		Permanent habitat alteration; fragmentation; air and noise emissions from traffic; and vehicle/wildlife interactions

Table 4.5 Potential Interactions Between Project Related Activities and Valued Environmental Components

Project Activities	Atmospheric Resources	Groundwater Resources	Fish and Fish Habitat	Wetlands	Rare Herpetiles	Rare Mammals and Critical Habitat	Rare and Sensitive Birds	Rare Plants and Plant Communities	Potential Effects
MALFUNCTIONS AND ACCIDENTAL EVENTS									
Hydrocarbon spills or leaks: spills or leaks of fuels, hydraulic fluid during construction	✓	✓	✓	✓	✓	✓	✓	✓	Soil/groundwater contamination; contaminated runoff; spill into surface water; ingestion/uptake of contaminants by wildlife
Vehicular accidents: collisions; spills of hazardous materials (cargo)		✓	✓	✓	✓	✓	✓	✓	Soil/groundwater contamination; contaminated runoff; spill into surface water; ingestion/uptake of contaminants by wildlife
Fires	✓	✓	✓	✓	✓	✓	✓	✓	Destruction to habitat; disruption and potential mortality to wildlife; smoke emissions; runoff associated with fire-fighting materials

Table 4.6 Potential Interactions Between Project Related Activities and Valued Socioeconomic Components

Project Activities	Local Economy	Land Use	Transportation	Archaeological and Heritage Resources	Potential Effects
CONSTRUCTION					
Site Preparation: surveying; clearing; grubbing	✓	✓	✓	✓	Disturbance to existing and anticipated land uses due to property acquisition and fragmentation; loss of forestry resources and/or limited access to forestry lands; disruption of recreation activities; noise and dust emissions from construction equipment; disturbance to archaeological resources where present; disruption of current traffic patterns; employment opportunities due to construction activities.
Roadbed Preparation: blasting; ripping; placement of fill; grading	✓	✓	✓	✓	Disturbance to existing land uses due to noise and dust emissions; disturbance to archaeological resources where present; disruption of current traffic patterns; employment opportunities due to construction activities.
Watercourse Crossing: site preparation; stream diversion; culvert installation; restoration	✓	✓		✓	Disturbance to existing land uses due to air and noise emissions from construction equipment; disruption of recreational fishing activities; disturbance to archaeological resources where present; employment opportunities due to construction activities.
Surfacing and Finishing Activities: paving; line painting; guard rail installation	✓	✓	✓		Disturbance to existing land uses due to air and noise emissions from construction equipment; disruption to existing traffic patterns; employment opportunities due to construction activities.

Table 4.6 Potential Interactions Between Project Related Activities and Valued Socioeconomic Components					
Project Activities	**Local Economy**	**Land Use**	**Transportation**	**Archaeological and Heritage Resources**	**Potential Effects**
OPERATION AND MAINTENANCE					
Road and RoW Maintenance: asphalt repair; repainting; shoulder regrading; mowing	✓	✓	✓		Noise and air emissions from equipment; temporary disruption to existing traffic patterns; employment opportunities due to construction activities.
Winter Maintenance: salt application; snow plowing	✓		✓		Public safety and transportation improved through road condition improvement; noise emissions and heavy machinery; employment opportunities due to construction activities.
Highway Operation: presence of RoW; vehicular traffic	✓	✓	✓		New limited access highway will alter existing traffic patterns, alleviating existing heavy traffic conditions and improving driver safety; reduction in pass-by customers in commercial establishments; build up of commercial activities near interchange locations; opening of new areas for residential, industrial and commercial development; improvement in overall regional transportation system; faster access to recreation and tourism areas; increased access to market; disturbance to adjacent land use by noise, lights, and air emissions from highway use; limited access to forestry lands; disruption of recreation activities alteration of community land use pattern due to road development access limitations; vehicle/wildlife interactions.

Table 4.6 Potential Interactions Between Project Related Activities and Valued Socioeconomic Components

Project Activities	Local Economy	Land Use	Transportation	Archaeological and Heritage Resources	Potential Effects
MALFUNCTIONS AND ACCIDENTAL EVENTS					
Hazardous Materials Spills: spills or leaks of fuels, hydraulic fluid during construction		✓		✓	Soil/groundwater contamination; effects on property values; interference with enjoyment of property; disturbance to archaeological and heritage resources; offsite
Vehicular Accidents: collisions; spills of hazardous materials (cargo)		✓	✓	✓	Temporary effects on traffic flow ; effects on public safety; soil and/or groundwater contamination; disturbance to offsite archaeological and heritage resources where present
Fires		✓	✓	✓	Effects on public safety; disturbance to property; disturbance to above-grade archaeological and heritage resources; temporary effect on traffic flow

4.4 Environmental Effects Assessment Framework

The following subsections describe how the environmental effects assessment for each VEC/VSC is organized in Sections 5.0 and 6.0 respectively. Figure 4.1 illustrates the standard sequence of steps followed in the assessment for each VEC/VSC.

4.4.1 VEC Identification and Description of Ecological and Socioeconomic Context

To ensure that the assessment is holistic, the CEA Agency guidance documents (1994) require a description of the ecological and socio-cultural context for each VEC/VSC. The consideration of the current state of a VEC/VSC and any Project-related effects requires an evaluation of the relationship of each VEC/VSC with other components of the ecosystem or human systems (*i.e.*, trophic relationships). This section also describes each VEC/VSC to be assessed and the rationale for its selection.

4.4.2 Boundaries

An important aspect of the effects assessment process is the determination of the boundaries of the assessment. Temporal and spatial boundaries encompass those periods during, and areas within which, the VECs/VSCs are likely to interact with, or be influenced by, the Project. These boundaries may extend well beyond the limits of direct disturbance (*e.g.*, migratory species whose range extends beyond the area of physical disturbance associated with the Project). Other boundaries to be considered as appropriate include administrative and technical boundaries imposed by factors such as finite resources of data, time, cost, and labour, as well as technical, political, or administrative considerations or jurisdictions.

An important temporal consideration for this assessment is that the Project schedule is subject to the regulatory approval of the Project and completion of design and property acquisition and ultimately prioritisation of the Project itself. Some of these VECs/VSCs may change over that time (*e.g*, land use) possibly necessitating a review of aspects of the assessment pertaining to these VECs/VSCs to ensure currency of the information as the Project nears development.

4.4.3 Description of Existing Conditions

Existing conditions (*i.e.*, pre-Project) are described for each VEC/VSC. The description is restricted to a discussion of the status and characteristics of the VEC/VSC within the boundaries established for the assessment. This information is contained in Section 3, Environmental Setting, for each VEC/VSC in Section 5 and 6 respectively, and in Appendix C in varying levels of detail. In order to improve the focus and readability of the assessment, the description centres on aspects that are relevant to potential Project interactions; additional information is compiled as appendices and/or background studies, as necessary.

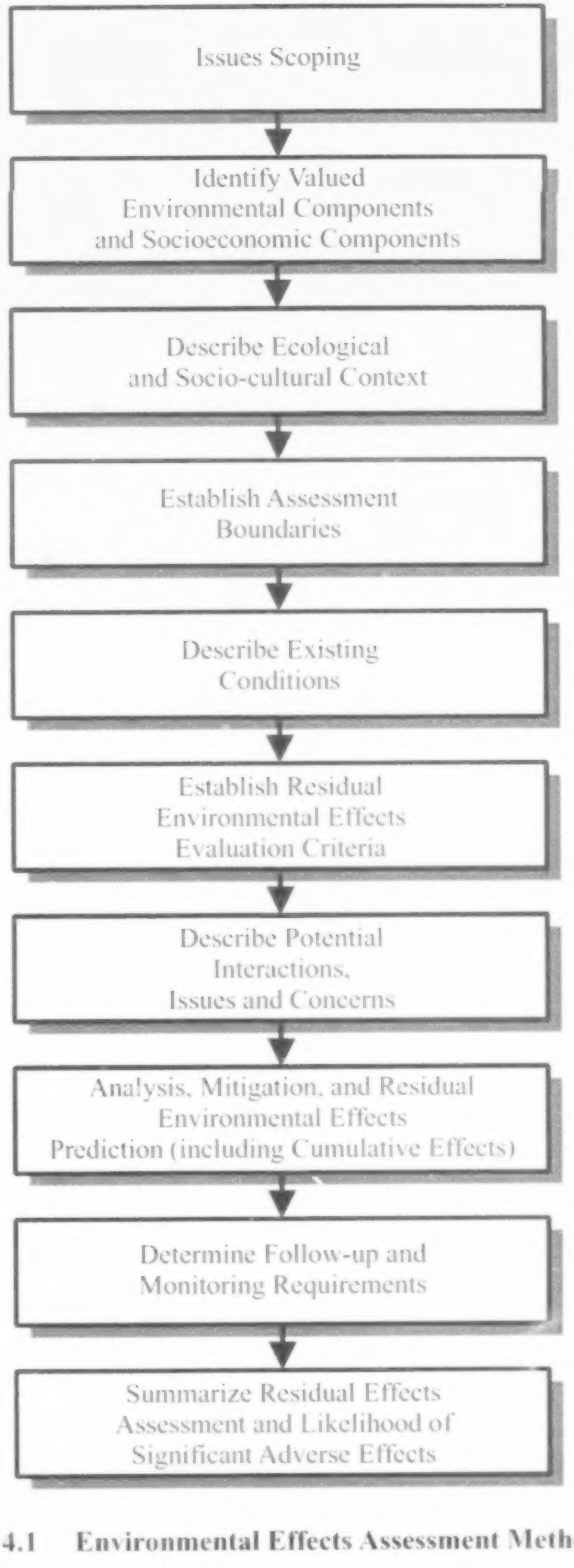

Issues Scoping
Identify Valued Environmental Components and Socioeconomic Components
Describe Ecological and Socio-cultural Context
Establish Assessment Boundaries
Describe Existing Conditions
Establish Residual Environmental Effects Evaluation Criteria
Describe Potential Interactions, Issues and Concerns
Analysis, Mitigation, and Residual Environmental Effects Prediction (including Cumulative Effects)
Determine Follow-up and Monitoring Requirements
Summarize Residual Effects Assessment and Likelihood of Significant Adverse Effects

Figure 4.1 Environmental Effects Assessment Methodology

4.4.4 Establishment of Residual Environmental Effects Evaluation Criteria

Section 16(1)(b) of the *Canadian Environmental Assessment Act (CEAA)* specifically requires that the significance of environmental effects be determined. Accepted practice in meeting this requirement involves establishing evaluation criteria for the determination of significance.

The CEA Agency (1994) lists criteria that should be taken into account in deciding whether adverse environmental effects are significant. These criteria include, among other factors:

- magnitude;
- geographic extent;
- duration;
- frequency;
- reversibility; and
- ecological and/or socio-cultural context.

These criteria have been considered in this assessment with regard to the determination of significance for each VEC/VSC. It is also necessary to define the threshold beyond which an effect is considered, for the purpose of this assessment, to be significant. For each VEC/VSC, a definition is provided for 'significant adverse environmental effect' and 'positive effect'. These significance definitions are generally population- or community-based, but may be based on regulatory standards or limits, where these exist for a particular VEC/VSC.

4.4.5 Potential Interactions, Issues and Concerns

Potential interactions with VECs/VSCs (*i.e.*, a description of the degree to which the VECs/VSCs are exposed to each Project activity as indicated in Tables 4.5 and 4.6), are described in the assessment. Where appropriate, the assessment includes a summary of major concerns or hypotheses of relevance regarding the effect of each Project activity on the VEC/VSC being considered. Where existing knowledge indicates that an interaction is not likely to result in an effect, certain issues may not warrant further analysis.

4.4.6 Analysis, Mitigation, and Residual Environmental Effects Prediction

The assessment focuses on the evaluation of potential interactions between the VECs/VSCs and the various Project activities outlined in the Project Description. A standard evaluation system has been developed to ensure that potential effects are clearly and completely evaluated. The prediction of residual effects follows three general steps, as outlined by the CEA Agency (1994):

- determining whether the environmental effects are adverse;
- determining whether the adverse environmental effects are significant; and
- determining whether the significant adverse environmental effects are likely to occur.

The effects assessment analysis conducted for each VEC/VSC is summarised in a template matrix. The residual environmental effects assessment matrix summarizes the effects by Project activity for construction, and operation and maintenance phases, and describes the mitigation for each activity (Table 4.7). The modifiers used to characterize the various criteria considered in the determination of effect significance (based on magnitude, geographic extent, duration, frequency, reversibility, and ecological and/or socio-cultural context) may vary for different VECs/VSCs.

Determining Whether Environmental Effects are Adverse

The effects evaluation for each VEC/VSC is conducted by Project phase (construction, operation and maintenance). For each phase, the study team selects those Project activities that may result in a positive or adverse effect.

To determine if there are adverse effects, the study team considers a number of factors, including those recommended in the CEA Agency guidance documents (1994):

- negative effects on the health of biota;
- loss of rare or endangered species;
- reductions in biological diversity;
- loss of critical/productive habitat;
- fragmentation of habitat or interruption of movement corridors and migration routes;
- transformation of natural landscapes;
- discharge of persistent and/or toxic chemicals;
- toxicity effects on human health;
- reductions in the capacity of renewable resources to meet the needs of present and future generations; and
- loss of current use of lands and resources for traditional purposes by Aboriginal persons.

Where adverse or positive effects are identified, the Project activity and the effects are listed in the matrix.

Table 4.7 Residual Environmental Effects Assessment Matrix

VEC/VSC (Project Phase)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effect	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Socio-cultural and Economic Context		

KEY

Magnitude: 1 =Low: *i.e.*, within the normal variability of baseline conditions. 2 = Medium: *i.e.*, increase/decrease with regard to baseline but within standards and objectives; 3 =High: *i.e.*, singly or as a significant contribution in combination with other sources causing exceedances or impingement upon standards and objectives beyond the property line of the project

Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity, 3 = Evidence of adverse effects.

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

Determining Whether the Adverse Environmental Effects Are Significant

Analysis and Residual Environmental Effects Prediction

The analysis evaluates the interactions between Project activities and the VEC/VSC and determines the significance of any residual adverse environmental effects (*i.e.*, effects that may persist after all mitigation strategies have been implemented). The study team evaluates possible residual environmental effects according to the evaluation criteria established for the VEC/VSC. These effects are assigned a rating of significant adverse, non-significant adverse, or positive. The team's evaluation includes consideration of specific mitigation strategies and the residual environmental effects evaluation criteria mentioned above. Supporting discussion in the text highlights particularly important relationships or data identified in the matrix.

To comply with the requirements of Section 16(1)(a) of the *CEAA*, cumulative environmental effects of past, present, and likely future projects are considered. The concept of cumulative environmental effects also recognizes that the environmental effects of different human activities can combine and interact with each other to cause cumulative effects that may be different in nature or extent from the effects of individual activities. Cumulative effects assessment has been undertaken in this screening based on projects scoped and assessed for each VEC/VSC. The residual environmental effects prediction in the assessment incorporates cumulative effects.

Level Of Confidence

The significance of the residual environmental effects of the Project on a VEC/VSC is evaluated based on review of relevant literature, consultation with experts, and professional judgement. In some instances, limitations in the available data make effect predictions difficult. Ratings are therefore provided to indicate the level of confidence with which the study team makes each prediction.

Overall Residual Effects Rating by Phase

After completing the assessment of specific Project activities, the study team evaluates the residual effects by Project phase. This overall rating considers all residual adverse effects, including cumulative effects.

Determining Whether the Significant Residual Adverse Environmental Effects are Likely to Occur

The CEA Agency (1994) has provided criteria for determining the likelihood of significant residual adverse environmental effects including:

- probability of occurrence; and
- scientific uncertainty.

Where possible, the assessment can apply statistical methods to determine the likelihood of significant residual effects. Where such methods are not feasible, a qualitative approach based on non-statistical analyses or professional judgement is used.

4.4.7 Follow-Up and Monitoring

Section 16(2)(c) of the *CEAA* require consideration of the need for, and requirements of, any follow-up studies. These are evaluated for each VEC/VSC. Requirements for follow-up and monitoring are linked to the sensitivity of a VEC/VSC to both Project-related and cumulative environmental effects. The likelihood and importance of such effects, as well as the level of confidence associated with the adverse residual effects rating, are also taken into consideration.

4.4.8 Summary of Residual Effects Assessment

This section summarizes the adverse environmental effects on each VEC/VSC by Project phase. It also addresses the likelihood of all predicted significant adverse effects. The likelihood of a significant adverse environmental effect is based on scientific knowledge with reference to statistical significance, quantitative risk assessment, or professional judgement.

5.0 ENVIRONMENTAL EFFECTS ASSESSMENT

5.1 Atmospheric Resources

Atmospheric Resources are considered to be a VEC due to their intrinsic importance to the health and well-being of humans, wildlife, and vegetation. This section addresses the potential for airborne pollutants and the potential local effects on air quality. It also considers the potential effects of noise generated by the Project.

Noise is defined as unwanted sound. Air and noise emissions are of most concern for potentially sensitive receptors such as residential land uses (discussed in Section 6.2). Air emissions and noise are also generated by traffic, which is discussed further in Section 6.4.

5.1.1 Boundaries

Spatial boundaries for the assessment of atmospheric resources consider the area of the proposed alignment for Highway 104 and surroundings. Project related effects on air quality are not expected to extend beyond approximately 200 m of the RoW. Spatial boundaries for the assessment of Project-related noise include all sensitive receptors (*e.g.*, residential areas, schools, hospitals, retirement homes, chronic care facilities, designated parklands, and recreational facilities) within 300 m of the Project area. The 300 m range is the distance at which the noise output from a typical piece of heavy machinery under load will attenuate to below the NSDEL night-time guideline of 55 dBA.

Temporal boundaries for this assessment include the construction and operation phases of the Project. The temporal boundary for the assessment is continuous during Project construction and operation as the adjacent area is populated and active year-round. Residential areas are the most sensitive receptors for noise impacts at night. In residential areas, noise levels are usually dominated during the day by traffic, property maintenance and recreational activities. At night, local traffic is greatly reduced so that noise from the nearest arterial roads and industry may be the most dominant perceived source. Other temporal issues include seasonal considerations when residents of the study area may be engaged in a greater number of outdoor activities and potentially subject to a greater amount of noise and dust.

5.1.2 Description of Existing Conditions

Air Quality

The Project area, and Nova Scotia in general, has good air quality due to the combination of maritime climate and relatively small population and industrial bases (NSDOE 1998). Climatic conditions provide good dispersion of air contaminants. The ambient air quality also benefits from the infusion of relatively clean polar and arctic air masses. Occasionally, however, long-range transport of air masses from central Canada or the eastern seaboard may transport contaminants into the area, causing poorer air quality.

Ambient air quality is monitored in Nova Scotia with a network of 28 sites, operated by NSDEL, Environment Canada, and Nova Scotia Power Inc. (NSPI). The NSDEL monitoring site nearest the study area is located at the Pictou Museum and monitors sulphur dioxide (SO_2), total reduced sulphur, and total suspended particulates (TSP). Monitoring sites in Halifax and Point Tupper are the nearest to the Project which monitor nitrogen dioxide (NO_2), carbon monoxide (CO), Hydrogen Sulphide (H_2S) and ground level ozone (O_3). These sites are jointly operated by NSDEL and Environment Canada.

In general, the air quality of Nova Scotia meets the desired federal ambient air quality criteria, with one-hour maximums below maximum acceptable limits for CO, NO_2 and TSP (refer to Table 5.1). Occasional hourly exceedances for SO_2 and H_2S occur in localized areas with high industrial activity (*i.e.*, Point Tupper) (NSDOE 1995b) (Table 5.1). Hourly exceedances of ground level ozone have occurred on an occasional basis over the entire province, but are the most severe in southwestern Nova Scotia. The ozone is associated with long range transport of pollutants from central Canada and the US (NSDOE 1998).

The proposed Project is located in an area of northern Nova Scotia which has some heavy industry present in the form of an NSPI power plant and the Trenton metal works near New Glasgow (approximately 60 km). In the *1995 Ambient Air Quality in Nova Scotia* (NSDOE 1995b), the Pictou Region had only one exceedance of the air quality objectives. This was a high TSP result which had been due to unusual helicopter activity in the vicinity of the sampling equipment. It may therefore be assumed that ambient air quality of the study area generally meets the desired criteria, except when long-range transport results in high levels of ozone.

Table 5.1 Maximum Values for Air Quality Parameters Measured at Monitoring Stations in Nova Scotia

Parameter	Reported Maximum	NSDEL Limit	Time Period	Location
SO_2	33.5 pphm	34 pphm	hourly	Pictou (NSPI)
TRS[1]	13 ppb	30 ppb	hourly	Pictou
TSP	187 $\mu g/m^3$	120 $\mu g/m^3$	24 hours	Pictou
H_2S	84 ppb	30 ppb	hourly	Point Tupper
CO	3.8 pphm	31 pphm	hourly	Halifax
NO_x	7.8 pphm	21 pphm	hourly	Halifax
O_3	2 exceedance events	82 ppb (objective)	hourly	Halifax

[1] Total Reduced Sulphur (TRS)

Source: NSDOE 1995b

Noise

Noise Guidelines

The regulation of noise in Nova Scotia is established through the Nova Scotia Department of Environment Guidelines for Noise Measurement and Assessment (Noise Guidelines) (NSDOE 1989) as follows.

- Leq 65 dBA between 0700 h and 1900 h
- Leq 60 dBA between 1900 h and 2300 h
- Leq 55 dBA between 2300 h and 0700 h

Since the effect on land use may be significantly influenced by noise from highway construction and operation, the Noise Guidelines recommend values for residential or sensitive areas defined as "areas where people normally live, work, or take part in recreation". This does not apply to company work forces, which are protected under the *Occupational Health and Safety Act.*

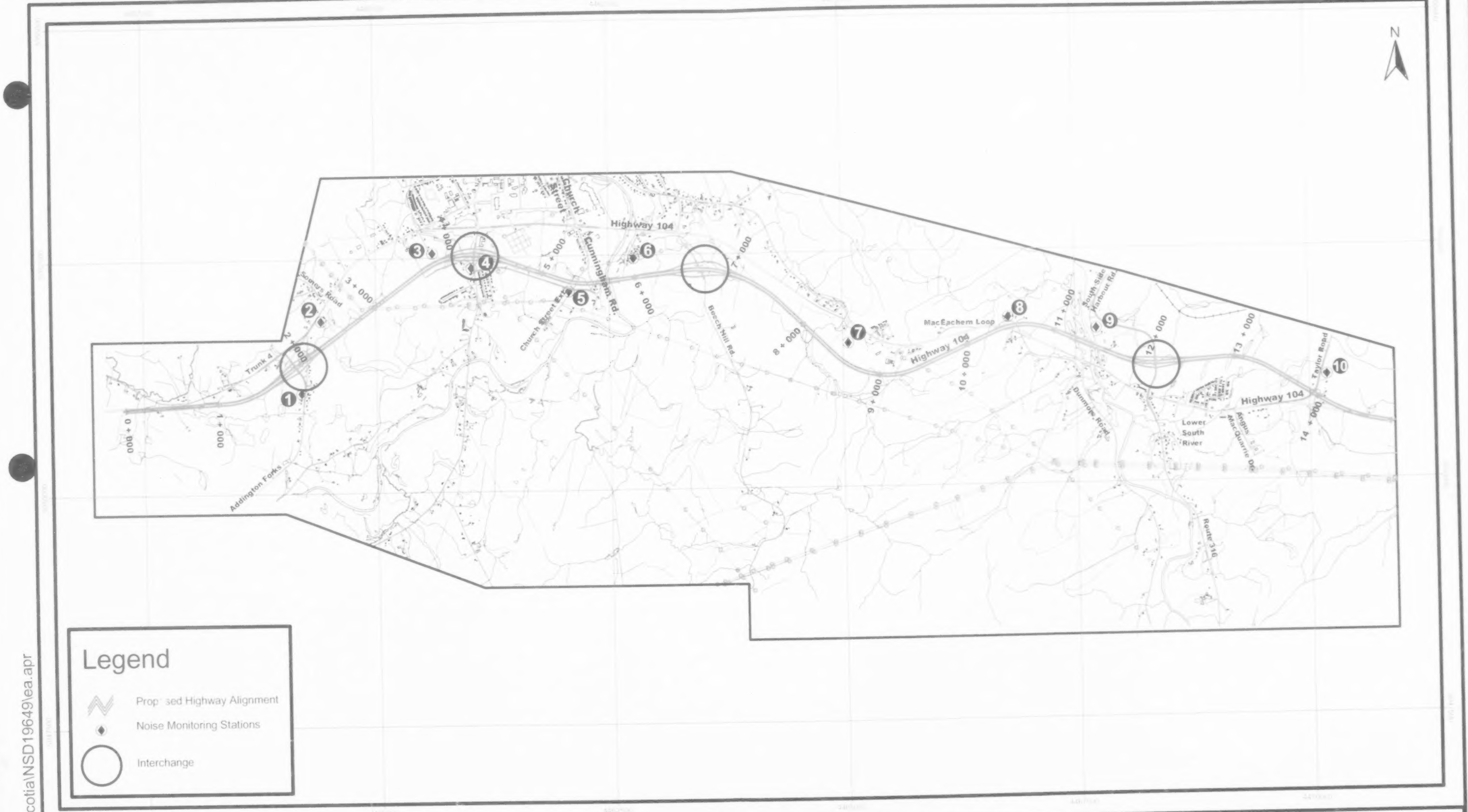
Ten sites were identified to be monitored for a baseline noise study and are identified on Figure 5.1. The locations were selected to provide sufficient baseline data coverage of potentially sensitive receptors and enable noise prediction for all these properties. For example, one sample station is considered adequate for several homes closely situated together. Factors affecting noise propagation (*i.e.*, trees, topography) at particular properties have been observed and recorded.

Field Conditions

Meteorological conditions, particularly wind, may affect recorded noise levels. Baseline noise readings were taken between August 12 and 17, 2002. Conditions during which monitoring was performed were hot, with clear to partly cloudy skies and calm to light winds (20 km/hr or less). Relative humidity ranged between 75 and 100 % during the monitoring dates.

Measurement

Sound levels were taken using Larson Davies Model 824 and Bruel & Kjaer Model 2236 integrating sound level metres. These instruments average the energy level of sound over a selected period of time and express this as L_{eq} in dBA (A-weighted decibels). An L_{eq} is the expression of equivalent level of sound energy over the referenced time period and is the most commonly used environmental noise descriptor (Cowan 1994). Each measurement session was comprised of data logged one minute L_{eq} readings over defined time periods. Measurements were then used to calculate hourly L_{eq} values. Pursuant to the Noise Guidelines, measurements were taken during portions of three daily periods: day (07:00 to 19:00), evening (19:00 to 23:00) and night (23:00 to 07:00).



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Jacques Whitford

NOVA SCOTIA
Transportation and Public Works

SCALE: 1 : 37 500
Date: 9/01/2004
Drawn By: GM
Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Noise Monitoring Stations

.5 0 .5 1.0 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.
NSD16949
FIGURE 5.1

Baseline noise levels were tabulated and compared with the Noise Guidelines. Where noted by field staff, area noise sources have also been listed. A summary of field measurements is presented in Table 5.2.

The values recorded at all baseline locations demonstrate typical levels expected in rural communities. The main sources of noise noted during the survey were traffic along the existing Highway 104 or local roadways, and normal residential outdoor activity. The data shows there is no existing exceedance of the Noise Guideline levels for any time of day (Table 5.2). Location 6 does show hourly levels near the Guideline limit during the morning hours (between 8:00 and 9:00 am) but the raw data indicates this is due to a series of short noise events which are not typical for residential areas.

Table 5.2 Baseline Noise Monitoring Hourly Summary

Time of Day	Monitoring Station										Guideline
	1	2	3	4	5	6	7	8	9	10	
12:00:00	51.1										65.0
13:00:00	51.9										65.0
14:00:00	52.2										65.0
15:00:00	52.9		47.0								65.0
16:00:00	51.9		46.6		50.8	48.9	51.1	51.1	53	50.9	65.0
17:00:00	49.2	51.9	47.5	55.7	47.7	46.8	50.8	50.2	54.2	50.3	65.0
18:00:00	50.1	52.0	46.3	54.7	43.6	44.9	50.4	49.3	51.9	50.4	65.0
19:00:00	47.3	50.8	46.4	53.6	42.1	44.7	51	45	52.5	50.5	60.0
20:00:00	44.5	51.8	44.5	52.7	43.7	46.5	50.2	38.3	52.6	50.5	60.0
21:00:00	41.2	49.4	43.2	51.9	45.6	44.8	47.7	37.4	52.8	48.6	60.0
22:00:00	45.4	49.3	43.9	50.3	39.4	44.6	46.5	36.8	53.9	46.7	60.0
23:00:00	36.7	48.3	41.4	49.4	38.8	43.2	45.2	36.3	53.6	46.1	55.0
0:00:00	36.6	49.1	39.3	46.9	34.8	42.6	43.0	36.5	53.3	43.5	55.0
1:00:00	45.3	47.2	43.8	43	31.8	42.3	42.7	34.5	52.8	42.8	55.0
2:00:00	51.7	45.9	39.3	42.7	39.2	42.2	43.1	33.3	51.6	43.7	55.0
3:00:00	50.5	45.2	41.0	45.9	32.9	41.6	41.2	34.8	54.2	42.2	55.0
4:00:00	50.9	46.8	43.2	46.0	30.5	40	40.0	35.7	53.7	40	55.0
5:00:00		48.5	46.2	50.9	38.6	44.3	40.4	39.6	51.8	40.3	55.0
6:00:00		48.6	47.7	53.2	41.9	49.1	45.3	39.7	51.9	45.7	55.0
7:00:00		48.4	46.7	54.8	54.1	62.1	48.3	48.3	52	48	65.0
8:00:00		49.3	42.1	54.4	57.3	65.0	49.2	47.1		48.6	65
9:00:00										56.1	65

5.1.3 Residual Environmental Effects Evaluation Criteria

Air Quality

Total suspended particulate (TSP) has been the air quality parameter of most concern for highway construction in Nova Scotia. The TSP guideline is therefore the principal parameter considered in the determination of the significance of potential air quality impacts.

A **significant** adverse environmental effect is defined as one that would reduce air quality, such that the level of TSP matter exceeds 120 $\mu g/m^3$ over a 24 hour averaging period or 70 $\mu g/m^3$ over an annual averaging period. These limits are specified as the 'maximum permissible ground level concentrations' under the Nova Scotia *Air Quality Regulations* and as the 'maximum acceptable' limits under the *Canadian Environmental Protection Act (CEPA)* Ambient Air Quality Objectives.

A **positive** effect occurs when there is a predicted or expected improvement in ambient air quality and mitigative measures in the area affected by Project activities.

Noise

A **significant** adverse environmental effect with respect to noise may be defined by any of the following:

- a noticeable change in noise level (approximately 5 dBA) which results in exceedance of the Noise Guideline levels;
- a noticeable change in noise level (approximately 5 dBA) above existing noise levels in areas where the guideline levels are already exceeded; or
- a change in noise level of approximately 10 dBA above existing noise levels in areas where the Guideline levels are not exceeded.

The severity of change combined with the resulting overall L_{eq} (equivalent continuous sound level measurement) will determine mitigation requirements and residual effect.

A **positive** effect occurs when Project-related activities result in a reduction in ambient noise level (*i.e.*, through the construction of sound barriers).

5.1.4 Potential Issues, Interactions and Concerns

Air Quality

The main potential interaction of the proposed Project with atmospheric resources is through dust generation from construction activities, and emissions such as sulphur compounds, carbon dioxide, carbon monoxide and nitrogen oxides from vehicles during construction and operation of the highway. Potential effects associated with malfunctions and accidental events are discussed in Section 7.0. Weather conditions and their effect on highway operation is also a potential issue of concern.

Noise

Depending on the number and location of sensitive noise receptors (*i.e.*, residential properties, schools, hospitals, etc.), and factors affecting the distance over which noise travels (*i.e.*, vegetation, topography, meteorological conditions), the effects of noise will vary. In general, noise due to construction and noise due to operation of a highway are different, and may affect receptors differently.

Noise due to construction is usually louder than normal highway operation, but is of relatively short duration and is also very localized. It can affect land uses directly adjacent to the RoW. Highway construction will involve typical road building activities such as clearing and grubbing, roadbed preparation and grading, and paving operations. Table 5.3 lists the noise outputs of construction machinery commonly used for these activities. The level of activity on construction sites will always vary with the level of activity on the site.

Table 5.3 Typical Construction Equipment Noise

Equipment Powered By Internal Combustion Engines	Noise Level dBA at 4.5 m (15 ft)
Earth Moving	
Compactors (Rollers)	75-87
Front Loaders	72-93
Backhoes	72-99
Tractors	76-96
Scrapers, Graders	80-94
Pavers	86-88
Trucks	82-94
Materials Handling	
Ashpalt Paver	80-86
Concrete Mixers	77-85
Concrete Pumps	82-84
Cranes (Moveable)	75-86
Cranes (Derrick)	86-88
Stationary	
Pumps	68-72
Generators	72-82
Compressors	75-91
Impact Equipment	
Jack Hammers and Rock Drills	82-98
Impact Pile Drivers (Peaks)	95-105

Source: May 1978; Cowan 1994

Operational traffic noise from the Project will affect sensitive receptors adjacent to the new alignment, and may also result in a positive effect for receptors adjacent to the existing Highway 104. The new alignment will remove some traffic noise from the existing Highway 104, and add a new roadway to areas less accustomed to highway noise. The traffic on the new highway will be travelling at higher speeds, and may therefore generate more noise; however the noise levels would be more consistent due to the removal of stop and go patterns (*i.e.*, less acceleration/deceleration).

5.1.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.1.5.1 Construction

Air Quality

There is potential for dust generation from construction activities, particularly during site preparation and sub-grade development. Grubbing operations generally create few dust problems since the exposed soil is usually moist and the grubbed areas are seldom left exposed for extended periods. The removal of existing structures and roadways may create some particulate emissions. Blasting, handling of fill, dumping, grading and compaction are potential sources of airborne particulates which may affect any residences within sight of the activity. Until the roadbed is paved, the movement of construction vehicles over unconsolidated fill may generate suspended particulate matter, especially where these vehicles cross from the exposed area to a paved roadway. Dirt or mud clinging to the vehicles will be dispersed into the air as the vehicle accelerates or will fall onto the public roadway to be stirred up by other vehicles. In general, the dust is expected to disperse within 200 m of the generation point.

Residential properties within 200 m of the proposed alignment include those located: along Trunk 4 where it nears the proposed alignment; Addington Forks Road; along Trunk 7; Kell Road; Silver Birch Drive; Dunn's Loop; South Side Harbour Road; and Taylor Road. These homes may be exposed to dust from heavy vehicles within the construction area.

Heavy equipment used in highway construction are typically powered by diesel engines. Exhaust from this equipment includes sulphur dioxide, sulphate particles, carbon dioxide, carbon monoxide and nitrogen oxides (AP-42). The number and distribution of the equipment during typical construction practices will allow for sufficient dispersion of these emissions to prevent significant impact on local air quality during most atmospheric conditions.

Adherence to standard practices as outlined in the Environmental Code of Good Practice for General Construction (Environment Canada 1979) and the Environmental Code of Good Practice for Highways and Railways (Storgaard and Associates 1979) will reduce the potential impact of dust on air quality. Dust control, when needed, will be achieved by application of water spray on exposed areas, and the cleanup of mud and dirt from paved roadways at access points to the site. Use of chemicals for dust control will be prohibited unless approved by the Project Engineer. By ensuring compliance with the above codes of good practice, in addition to procedures in the EPP, there is not likely to be any significant adverse residual environmental effects on air quality due to Project construction.

Forest and agricultural ecosystems have the ability to remove carbon from the atmosphere (as CO_2), and incorporate this carbon into plant biomass. The decay of this biomass leads to increases in the amount of carbon in soils. Preservation of these carbon 'sinks' is now recognized as an important measure in reducing atmospheric levels of CO_2. The Project will result in the disturbance of approximately 190 ha of forested land and 35 ha of agricultural land, and the potential loss of all carbon in the standing biomass on this land area. Construction activities may also lead to the loss of carbon from soils as a result of the disturbance of soils on the RoW. Loss of soil carbon occurs whenever soils are disturbed, and manipulated, and results from increased activity of soil micro-organisms.

Loss of carbon from standing forest biomass is considered to be insignificant in consideration of the extent of forest harvesting and re-forestation which now occurs in Antigonish County. During clearing operations, salvageable wood resources become the property of the landowner or clearing contractor and could be allocated for other processing, such as for use as fiber or lumber, in order to preserve some of this carbon in a non-atmospheric form. Minimizing the area of soil and vegetation disturbance during construction will help to mitigate losses of carbon from standing biomass and from soils.

Following construction activities, all areas with the exception of the road surfaces and shoulders, will be revegetated. Soil carbon that is lost during construction will therefore be replenished over time once roadside vegetation becomes established and is maintained.

Noise

Roadbed preparation and grading is the activity of longest duration and therefore will have the most potential for affecting nearby residents. Construction noise, for the purpose of this assessment, has been assumed to be generated by three machines (grader, loader and dump truck), working in a group. Based on the median output levels described in Table 5.3, this would give a combined sustained source level of about 92 dBA at a distance of 15 m and would attenuate 6 dBA for each doubling of distance as the source is localized (May 1978). As a result, any receptor within 400 m of the activity with no other mitigation present for noise would exceed the Noise Guidelines of 65 dBA for daytime noise levels. Any receptor within 80 m of the activity would exceed 80 dBA which is the level at which hearing protection is required by the Nova Scotia *Occupational Health and Safety Regulations*. Land clearing and roadbed paving are construction operations which are generally quieter and of shorter duration than roadbed preparation.

As shown on Figure 5.1, there are residences within 100 m of the RoW, particularly at Addington Forks Road, the trailer park near the Oasis Motel, Dunn's Loop and Taylor Road (Baseline stations 1, 7, 8, and 10 respectively). Mitigation of the potential construction noise will be considered for these residences, if necessary.

Residences are located within 400 m of the RoW, but further than 100 m, in the remaining areas identified for baseline monitoring (Stations 2, 3, 4, 5, 6 and 9), and the mobile home park in Lower South River. While construction noise in these areas is expected to exceed the daytime Noise Guideline of 65 dBA, the duration of these exceedances is expected to be relatively short (in the order of 1 to 2 hours at a time on any particular day). Consideration of mitigation for these residences will be made if conditions noted during construction activity are louder than expected or requires more than a normal amount of heavy equipment.

Mitigation of the noise during construction for the most directly affected areas (<100 m from construction site) can be accomplished by reducing the equipment working in these areas to either two or one units and keeping the equipment in good working order including mufflers. This may not bring levels to within Guidelines at all times; however, actual levels are expected to be lower than the maximum predicted most of the time as the machines will be constantly moving around and will not always be at the nearest point to any particular residence. Other mitigative options to reduce effects on the closest homes include landowner notification, restricting working hours and reducing the amount of continuous time spent by machinery in close proximity.

The use of physical barriers to block noise is the most common method to control noise where scheduling or otherwise reducing noise at the source is not possible. This is not practical in this case based on the expected short duration of construction, the physical location of these areas in relation to the corridors, and the expense of constructing barriers on a temporary basis.

Occasional, momentary noise sources such as the dumping of rock may be significantly louder than the working machinery (>125 dBA at the source); however these high sound levels attenuate quickly due to their short duration. The overall effect of these noise events on the average L_{eq} for the residents cannot be accurately determined due to the randomness and uncertainty of these events.

Provided that the above mitigation measures are adhered to, no significant adverse residual effects are predicted for land uses during construction.

5.1.5.2 Operation and Maintenance

Air Quality

The impact on air quality from traffic during operation of the new highway is expected to be low. The proposed alignment has been planned as an express corridor, with free flowing traffic. Exhaust from vehicles will therefore disperse quickly and there will be a reduced potential of local effects from stopped and idling traffic as is the present case near Antigonish. Improved traffic flow, on a regional scale, will reduce the overall emissions to the atmosphere. No mitigation is necessary for air emissions from highway traffic.

There is therefore not likely to be any significant adverse residual environmental effects on air quality as a result of Project operations.

Noise

To determine the overall environmental effects on land use in the study area, noise output from the highway in operation must be considered. This was accomplished by using the AAMA Constant Speed Community Noise Model V5.0, based on the US-FHWA Stamina model. Model inputs include the proposed and existing roadway locations, traffic types, speed and volumes for each roadway, baseline noise levels, locations of sensitive receptors and any terrain or elevation effects.

The potential traffic noise outputs from the new alignment were calculated based on the following assumptions/data:

- Annual Average Daily Traffic (AADT) volume for the new highway are as per Table 6.20 AADT Volumes (Section 6.4.2);
- average Nova Scotia highway vehicle mixes (cars vs transport trucks) in this area is 9 % heavy trucks, 8 % medium trucks, and 83 % passenger cars;
- the distribution of traffic over a 24-hour period along all roadways in the study area is 80 % between 0700 h and 2300 h and 20 % between 2300 h and 0700 h. Ten percent of the total AADT occurs during an unknown peak hour (represents a worst case scenario for traffic volumes);
- summer peak traffic volumes are 137% of the AADT; and
- vehicle speeds are 110 km/hr on the proposed alignment.

Expected volumes for the proposed alignment were established for each of the Noise Guideline time periods, as well as for the peak traffic hour for input into the model. These calculations do not account for daily or weekly variations in traffic volumes, but were calculated for maximum expected volumes. The model results are used to indicate the potential for significant increases in noise at sensitive receptors identified as residences represented by the 10 baseline monitoring stations. Each location was identified in the model in relation to the proposed alignment.

The model results, as presented in Table 5.4, indicate potential significant impact areas from traffic on the new highway.

Table 5.4 Traffic Noise Predictions Compared to Baseline Noise										
Station	Peak Hour (10 % of AADT)	Daytime (65 dBA)			Evening (60 dBA)			Late Night (55 dBA)		
	Predicted	Baseline	Predicted	Difference from Baseline	Baseline	Predicted	Difference from Baseline	Baseline	Predicted	Difference from Baseline
1	51.5	52.9	52.5	-0.4	47.3	52.5	5.2	51.7	49.7	-2.03
2	53.8	52.0	54.4	2.4	51.8	54.4	2.6	49.1	51.8	2.7
3	54.2	47.5	54.6	7.1	46.4	54.6	8.2	46.2	51.9	5.7
4	52	55.7	52.9	-2.83	53.6	52.9	-0.7	50.9	51.2	0.3
5	57.3	50.8	56.6	5.8	45.6	57.3	***11.72***	38.6	55.2	***16.6***
6	53.2	48.9	54.3	5.4	46.5	54.3	7.8	44.3	53.5	9.2
7	53.3	51.1	54.4	3.3	51.0	54.4	3.4	45.3	53.4	8.1
8	49.1	51.1	54	2.9	45.0	54	9.0	39.7	52.2	***12.5***
9	50	54.2	54.4	0.2	53.9	54.4	0.5	54.2	52.2	-1.1
10	50	50.9	55	4.1	50.5	55	4.5	46.1	53.7	7.6

Notes:

Expected traffic volumes used for Daytime and Evening predictions were the same, so one set of results was used.

Predicted significant effects have been bolded and italicized. Significance Criteria is defined as:

- a noticeable change in noise level (approximately 5 dBA) which results in exceedance of the Noise Guidelines;
- a noticeable change in noise level (approximately 5 dBA) above existing noise levels in areas where the Guideline levels are already exceeded; or
- a change in noise level of approximately 10 dBA above existing noise levels in areas where the Guideline levels are not exceeded.

Margin of error for this model is ± 2 dBA.

The model results predicted no Noise Guideline exceedances would occur during any of the NSDEL designated time periods, including during a daytime peak traffic hour condition. The worst case condition identified on Table 5.4 shows the highest expected Hourly L_{eq} due to highway operation is approximately 57 dBA near Site 5. While the peak hour for traffic in this area cannot be guaranteed to be similar to more urbanized areas, it is assumed the peak would occur during daytime hours.

Sites 3, 5 and 6 show the potential for significant noise increase at times of day due to the increased proximity of the highway, although Sites 3 and 6 are close enough to the existing Highway 104 for traffic noise to be presently audible. The sound of the new highway will appear louder for residences near Sites 3 and 6. Residents near Site 5 do not presently hear highway noise, and will find the change noticeable during daytime and evening hours.

There are significant increases of 10 dBA over baseline conditions expected at two locations (Sites 5 and 8), particularly at night. The traffic flows used for the nighttime period may not reflect the present volumes of traffic on the existing Highway 104 during these hours, but represent a probable worst case. Sites 6 and 7 will also have noticeable increased noise levels at night, but these increases are not considered significant when the predicted value is compared to the Noise Guideline. Sites 1 and 9 are not expected to change significantly at night, based on their locations relative to the existing and new alignments.

Site 5 along Kell Road will be particularly affected at night as residents in this area currently only experience traffic noise on the local roadway in addition to the normal noises due to residential land usage. Highway noise will be new to these homes, the nearest of which is within 200 m of the proposed RoW. Some form of standard mitigation such as an earth berm combined with minimising the elevation of the highway, may be considered for this location.

Site 8 at Dunn's Loop is also expected to have significant increased noise levels at night. The difference between baseline and predicted values may partly be due to the fact that the night the baseline monitoring was performed at a time which happened to have low traffic volumes. This does not diminish the potential for significant impact at this location, particularly since the highway is expected to pass over the existing roadway near this location. Natural attenuators, such as soft ground or heavy vegetation, will not significantly reduce the expected traffic noises. With the source of noise higher than the elevation of the residences in this area, standard mitigation such as earth berms or simple barriers may not be feasible. Construction of the highway as an underpass to the existing roadway to utilize the embankments as barrier may not be cost effective; however it will be considered an option for reduction of noise levels. An engineered barrier on the overpass structure is also an option for consideration.

In general, increases in traffic noise are expected along the entire alignment. These increases will likely be significant (>10 dBA above baseline conditions) at night, except where residences are presently very close to (within 200 m) the existing Highway 104. Increases are due to the proximity of the alignment to residential properties, and the general quiet found in the area, particularly those areas where no highway alignment has been present in the past. While noise levels are predicted to increase, none of the model results show the potential for noise levels at the residences to exceed the provincial Noise Guidelines limit for any of the defined time periods. There is expected to be a reduction in ambient noise levels along the existing Highway 104 with the diversion of through traffic to the proposed highway.

This assessment is generally broad-based, with the intent on identifying the potential for noise impact. The results above use a conservative approach by incorporating future predicted traffic volumes and vehicle balances that are likely higher than reality.

Standard mitigation for highway noise is through engineered solutions. Engineering solutions are generally to build a physical barrier, either an earth berm or solid structure, to block the line of sight (and thus propagation of noise which is generally linear) from the receiver to the source of the noise. Implementation of physical mitigation generally considers economic feasibility, effectiveness of the mitigation, and sensitivity of receptors.

Based on the above results, detailed examination of mitigation options will be considered near Sites 5 and 8, based on the expected increase in nighttime noise levels. Mitigative measures can be effectively applied to those areas where significant noise increases are predicted. Assuming effective application of mitigation at the locations noted, no significant adverse residual effects with respect to noise are anticipated during operation.

5.1.6 Follow-Up and Monitoring

Air Quality

If the proposed mitigative actions are taken, it is not anticipated that routine monitoring of dust from construction is required. However, dust monitoring may be required to address any complaints from residents received by NSTPW. If required, air sampling will be conducted in accordance with NSDEL and Environment Canada methodologies for High-Volume air sampling of total suspended particulate matter.

Noise

Specific post-construction noise monitoring is not proposed at this time. NSTPW maintains a practice of addressing community issues and concerns, including noise on an ongoing basis.

5.1.7 Summary of Residual Environmental Effects Assessment

Provided the proposed mitigative actions are implemented, no significant adverse residual effects from airborne dust on air quality during construction are anticipated. No adverse residual environmental effects from traffic on local air quality during Project operation are predicted. It is anticipated that most direct and indirect effects from Project construction noise can be effectively mitigated through giving early notification to potentially affected residents residing in proximity to the RoW and through restricting working hours. There is a potential for significant adverse effects related to increases of noise levels at several locations due to the operation of the new highway. Implementation of mitigative measures, including engineered solutions, can reduce these effects to non-significant levels. Noise along the existing Highway 104 will be reduced from its current levels. Tables 5.5 and 5.6 summarise the residual environmental effects assessment for atmospheric resources.

Table 5.5 Residual Environmental Effects Assessment Matrix
Atmospheric Resources (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Construction of Highway	Air Quality • Dust generation and construction vehicle exhaust (A) • Air and dust emissions (A)	• Standard dust control procedures • Complaint Resolution Policy • Clean up mud and dirt from paved roadways	1	1	1 / 2	R	2	N	3
	Noise • Noise emissions (A)	• Noise controls (*e.g.*, reducing amount of equipment and/or continuous time working in one place, landowner, notification) • Restricted working hours	2	4	3 / 1	R	2	N	3

KEY

Magnitude: 1 = Low: *i.e.*, within the normal variability of baseline conditions; 2 = Medium: *i.e.*, increase/decrease with regard to baseline but within standards and objectives; 3 = High *i.e.*, singly or as a significant contribution in combination with other sources causing exceedances or impingement upon standards and objectives beyond the property line of the project

Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects.

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

Table 5.6 Residual Environmental Effects Assessment Matrix
Atmospheric Resources (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Highway traffic	Air Quality • Vehicle emissions (A)	• No mitigation proposed for vehicle emissions	1	1	5 / 6	R	2	N	3
	Noise • Increased noise levels at residences, businesses and recreational areas (A)	• Noise mitigation at Sites 5 and 8	1	2	5 / 6	R	2	N	2

Refer to Table 5.5 for Key.

5.2 Groundwater Resources

Groundwater, an integral component of the hydrologic cycle, originates from percolation of rain, snowmelt, or surface water into the ground. This infiltrating water fills voids between individual grains in unconsolidated materials and fills fractures developed in consolidated materials. The upper surface of the saturated zone is called the water table. The water table intersects the surface at springs, lakes and streams where interaction between the groundwater and the surface water environment can occur. Groundwater flows through soil and bedrock from areas of high elevation (recharge areas) to areas of low elevation (discharge areas) where it exits the sub-surface as springs, streams, and lakes. There is a dynamic interaction between groundwater resources and surface water resources in Nova Scotia. Groundwater generally sustains the base flow of springs, streams and wetlands during dry periods of the year. More rarely, surface water bodies can contribute to groundwater storage under specific hydrogeological conditions.

Groundwater yield to dug or drilled wells can vary greatly, depending on the hydraulic properties of overburden or bedrock aquifers. An aquifer is a formation or group of formations that can store or yield useable volumes of groundwater to wells or springs. Natural groundwater quality is directly influenced by the geochemical composition of the aquifer materials though which it passes, and the time the water resides within that material.

The groundwater resource is a VEC because it provides potable water supply to approximately half of the total population of Nova Scotia, and to all of the unserviced residences adjacent to the proposed highway corridor.

5.2.1 Boundaries

Spatial boundaries for the assessment of groundwater resources are based on a combination of aquifer hydraulic properties, expected groundwater flow directions, and the distance between potential road cuts and wells that may be affected by Project activities. For example, the area of influence or capture area of a typical low yield domestic water well is usually less than about 100 m, and generally in a direction hydraulically up-gradient of the well. Project-related contamination (*i.e.*, road salt) within this capture area could potentially affect well water quality. Vibration damage to a drilled or dug well is generally a function of distance between the energy source and the well, and seismic properties of the aquifer materials. With respect to rock type, risk is greater for fractured crystalline bedrock than for overburden wells or sandstone wells. Based on experience, the risk from blasting or major excavation is considered to be greatest within 50 m, moderate from 50 to 200 m, and expected to be minimal beyond about 200 m.

To be conservative, blasting effects are considered for drilled wells within 500 m on both sides of the RoW in those areas found to require blasting for excavation. Potential effects of accidental spills are within 500 m hydraulically down-gradient of the RoW in areas of highly permeable media (*i.e.*, sand and gravel aquifers), or mineralized bedrock. Road salting effects are considered for all wells located hydraulically down-gradient of the alignment. The extent of the area potentially affected is dependent on surface drainage and surficial geology. In areas of poor drainage, prone to pooling, effects can reach an extent of 200 m in sand and gravel, and up to 50 m in till.

With respect to temporal boundaries, most physical and chemical effects on groundwater resources are likely to be temporary and to occur during the construction phase. Residual effects from road de-icing materials could occur throughout the operation phase of the Project.

A technical limitation for this assessment is that a well water inventory was not undertaken for this study. This preliminary assessment identifies areas of potential concern. A residential well water survey will be conducted of proximal wells prior to implementing blasting operations in specific areas at risk, or major excavations requiring de-watering. Refer to Appendix G for a typical residential well survey protocol.

5.2.2 Description of Existing Conditions

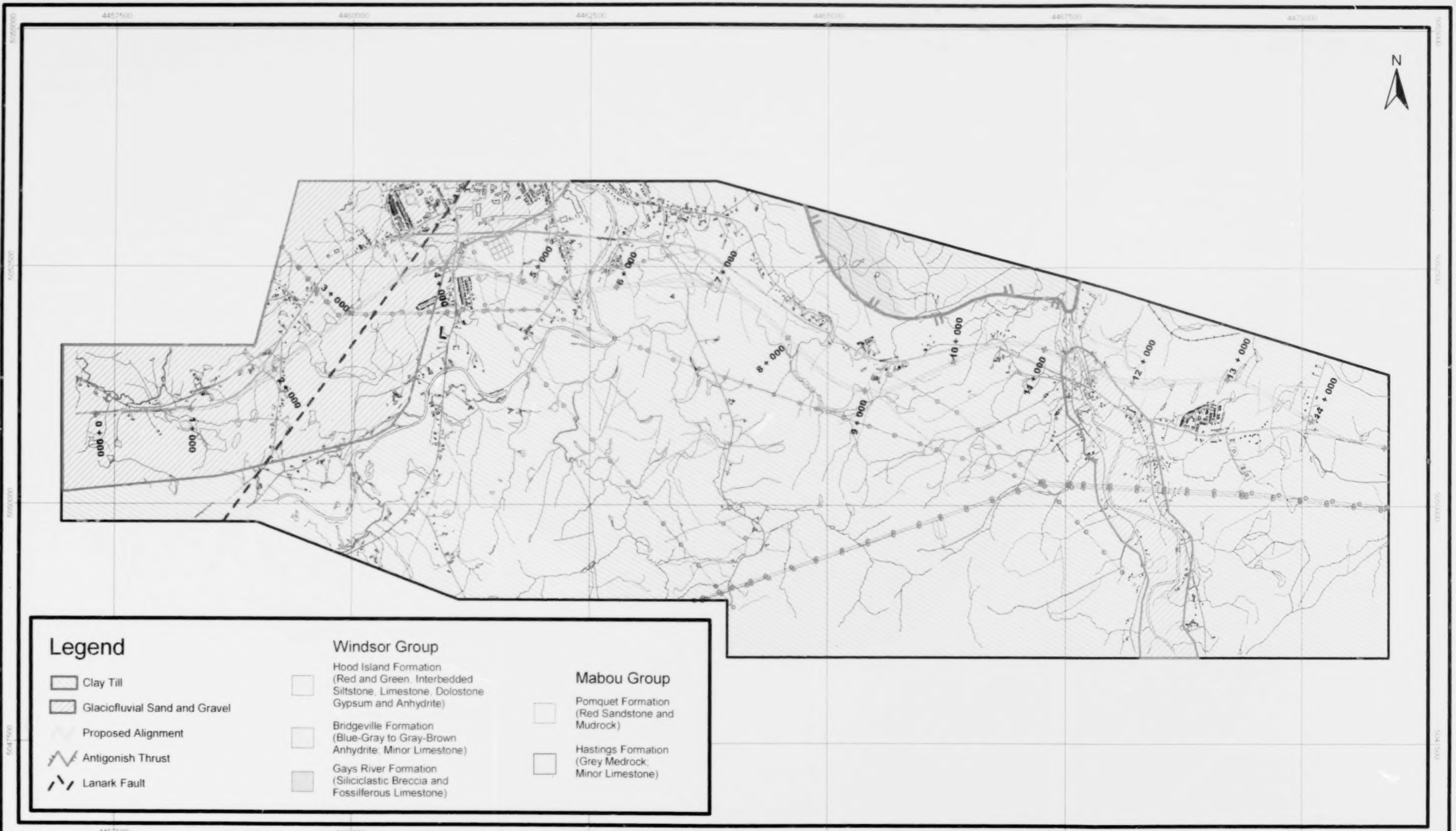
An assessment of the hydrogeological features of the Project alignment was performed using previously published mapping and hydrogeologic reports. A reconnaissance field trip was carried out on October 10 and 11, 2002 by a JW hydrogeologist to assess terrain and probable hydrogeological conditions on the site, and to provide a preliminary assessment of water well distribution along roads that will be traversed by the RoW.

Topography and Drainage

The Project alignment is located within the Antigonish Basin. The alignment follows within 600 m of the current Highway 104 alignment at elevations ranging from sea level at Lower South River, to just over 50 m above sea level, and generally drains northwards through streams and watercourses into Antigonish Harbour.

Overburden Geology

Overburden consists of glacial deposits derived from the underlying and 'up-ice' bedrock units, and soil which is derived from the parent glacial tills. This till and glaciofluvial material was laid down by major ice sheets advancing across the area from northwest to southeast. The overburden can be subdivided into clay till and sand/gravel glaciofluvial deposits (Figure 5.2). Based on available geological mapping, two types of glacial overburden deposits are identified along the proposed alignment.



Legend

▨ Clay Till

▨ Glaciofluvial Sand and Gravel

Proposed Alignment

Antigonish Thrust

Lanark Fault

Windsor Group

☐ Hood Island Formation (Red and Green, Interbedded Siltstone, Limestone, Dolostone Gypsum and Anhydrite)

☐ Bridgeville Formation (Blue-Gray to Gray-Brown Anhydrite; Minor Limestone)

☐ Gays River Formation (Siliciclastic Breccia and Fossilferous Limestone)

Mabou Group

☐ Pomquet Formation (Red Sandstone and Mudrock)

☐ Hastings Formation (Grey Medrock; Minor Limestone)

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NOVA SCOTIA
Transportation and Public Works

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Drawn By: GM
Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT
FOR THE PROPOSED HIGHWAY
104 AT ANTIGONISH

Surficial and Bedrock Geology

.5 0 .5 1.0 1.5 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.
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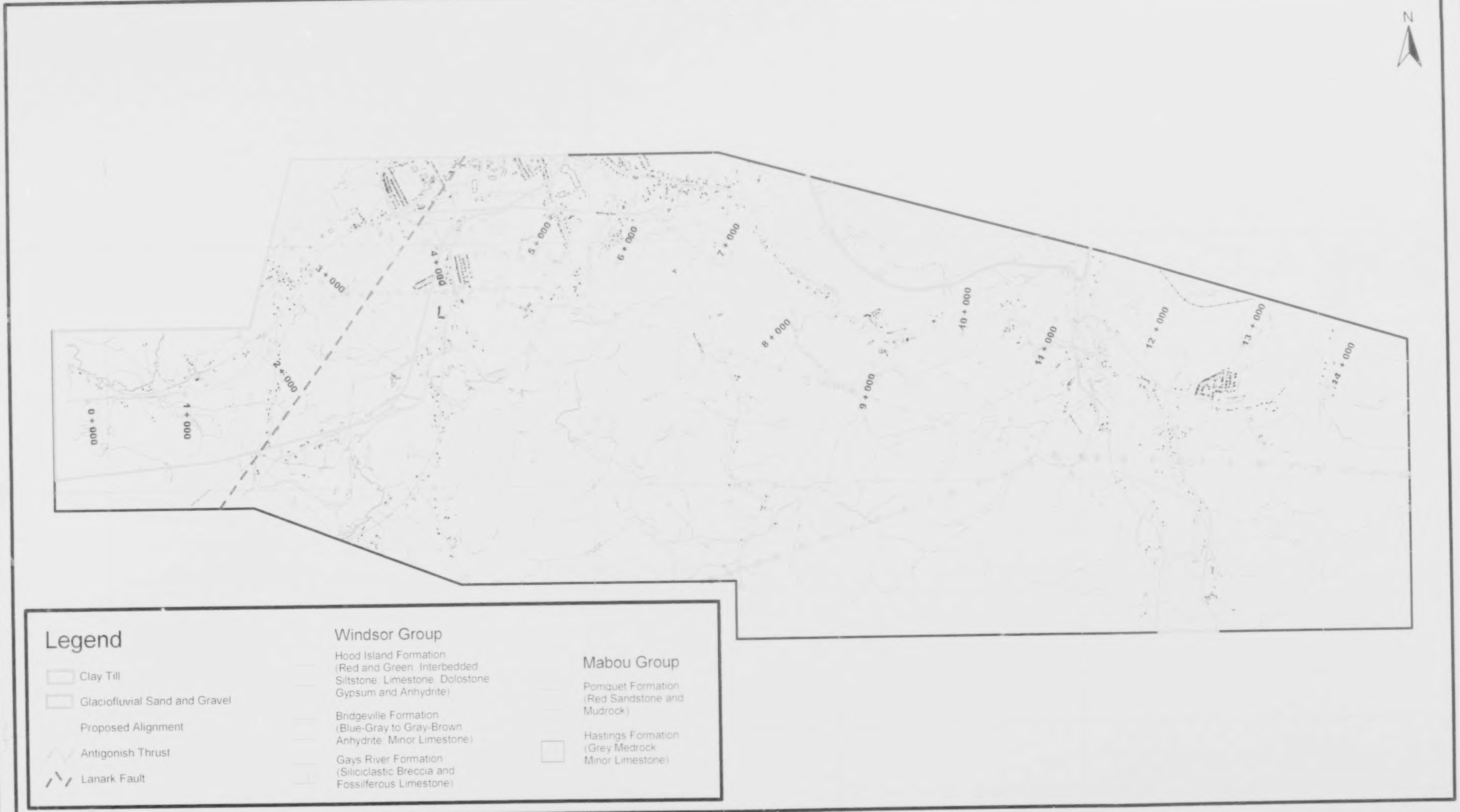
FIGURE 5.2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Legend
Clay Till
Glaciofluvial Sand and Gravel
Proposed Alignment
Antigonish Thrust
Lanark Fault
Windsor Group
Hood Island Formation (Red and Green, Interbedded Siltstone, Limestone, Dolostone Gypsum and Anhydrite)
Bridgeville Formation (Blue-Gray to Gray-Brown Anhydrite, Minor Limestone)
Gays River Formation (Siliciclastic Breccia and Fossilferous Limestone)
Mabou Group
Pomquet Formation (Red Sandstone and Mudrock)
Hastings Formation (Grey Medrock, Minor Limestone)

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ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Surficial and Bedrock Geology

.5 0 .5 1.0 1.5 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.
NSD16949
FIGURE 5.2

The clay till underlies the majority of the proposed alignment from the intersection of Trunk 7 and Highway 104 to the eastern end of the proposed alignment. These deposits are described as clay to silt till of varying depths and are generally considered to be a poor groundwater source.

The glaciofluvial sand and gravel deposits comprise poor to well sorted stratified sands and gravels. These deposits are located between the western end of the proposed alignment and the intersection of Trunk 7 with the current 104 Highway, and in the Village of Lower South River. These deposits are considered to be highly permeable and have a good potential as an excellent source of groundwater with yields of 20-100 L from shallow wells (Maritime Resource Management Service 1975a).

Bedrock Geology

Based on available geological mapping, the study area is underlain by 305 to 345 million year old, sedimentary bedrock of Early to Late Carboniferous age. In the study area (500 m north and south of the RoW), this bedrock forms a syncline made up of five geological formations; the Pomquet and Hastings formations of the Mabou Group (formerly the Canso Group) and the Hood Island and Bridgeville formation of the Windsor Group. The RoW traverses three of these bedrock units. In close proximity to the study area (600 m north of the RoW) is the Gays River formation of the Windsor Group (Boehner and Giles 1993) (Figure 5.2). A borehole investigation conducted at South River revealed that the contact between the Mabou and Windsor Group underlies the South River. The majority of the RoW over the central part of the alignment is underlain by red and green interbedded siltstone, limestone, dolostone, gypsum and anhydrite of the Hood Island Formation. Potential sinkholes (*i.e.,* Karst topography) could occur within this unit although none were identified during field investigations. The eastern and western ends of the alignment are underlain by mudstone and limestone of the Hastings Formation. The extreme eastern end of the alignment is underlain by sandstone and mudrock of the Pomquet Formation.

The study area intersects several faults including the Lanark Fault and the Antigonish Thrust as indicated on Figure 5.2. No bedrock outcrops were observed within the area at the time of the field reconnaissance, due to presence of thick glacial overburden. Bedrock exposures could however occur at stream crossings where the overburden has been eroded.

Occasional mineralized zones of lead and copper are known to occur as stratabound deposits within the study area (Boehner and Giles 1993). However, these formations are not typically associated with acid drainage problems and the geochemical nature of the bedrock and thick overburden deposits suggest a negligible potential for acid drainage risk.

Hydrogeology

The hydrogeology and hydraulic properties of the various hydrostratigraphic units underlying and within 500 m of the alignment are presented below in order of age and occurrence below ground surface. The capacity of each unit to store and transmit groundwater to wells and potential for impact from construction of a highway alignment is discussed.

Glacialfluvial Sand and Gravel

Areas of poor to well-sorted, stratified sand and gravel glacial outwash deposits with potentially higher permeability than till or bedrock occur in the vicinity of the western end of the alignment to approximately the Trunk 7 intersection of the proposed alignment, and near South River on both sides of the watercourse. These deposits are an excellent source of groundwater which is extracted via dug wells from the junction of Addington Forks Road and the existing 104 Highway to the western end of the proposed alignment along Trunk 4. The NSDEL inventory indicated only two dug wells, which were in the Trunk 4 area, and had depths of 8.2 and 4.9 m, water levels of 3.0 and 4.1 m, and one of the wells had a listed well yield of 568 L/min. Dug wells in glacial deposits are typically constructed by backhoe or excavator, and usually 4.5 to 6.1 m in depth, and generally provide sufficient water for single family needs. Depending on location, topography, and permeability of the overburden, some wells experience seasonal loss of water due to annual water table fluctuations in the order of 3 m or greater.

Based on twelve pumping tests in Antigonish County (Table 5.7), dug wells completed in the sand and gravel have an average transmissivity of 395 m^2/day, and a well yield ranging from 120 to 1027 L/min, and averaging 602 L/min (NSDEL Pumping Test Inventory (NSDEL 1973-2001)). Water quality within the glacialfluvial deposits is expected to be good, although concentrations of iron, manganese and hardness may locally exceed the Guidelines for Canadian Drinking Water Quality (Health Canada 1999) aesthetic criteria of 0.3, 0.05 and 120 milligrams per litre (mg/L), respectively. Depending on age, location and construction method, dug wells are highly prone to coliform bacteria and road salt impact. Approximately two-thirds of the residential water supply wells observed during the field reconnaissance were dug wells, which suggests a shallow water table within 3 to 4 m of ground surface.

Glacial Till

Stoney, gritty clay and silt till deposits of various depths typically underlies the majority of the proposed alignment and may locally underlie the sand and gravel deposits. This unit typically has a low hydraulic conductivity (K) in the order of 10^{-5} to 10^{-6} cm/sec, however, properly constructed dug wells may yield sufficient water for domestic supplies.

Mabou Group (Pomquet and Hastings Formations)

Mabou Group bedrock occurs over approximately one third of the proposed realignment RoW at both the eastern and western ends. The Mabou Group is made up of two principal formations which are the grey mudrock (minor limestone) dominated Hastings Formation, which is overlain by the younger red sandstone and mudrock dominated Pomquet Formation (Boehner and Giles 1993).

Based on six pumping tests in Antigonish County (Table 5.7), wells completed in the shale and sandstone bedrock have an average transmissivity of 7.4 m^2/day, and a typical well yield ranging from 15 L/min in shale to 250 L/min in sandstone, and averaging 124 L/min (NSDEL Pumping Test Inventory (NSDEL 1973-2001)). Groundwater quality from these formations can be expected to be of good chemical quality with a tendency toward hardness and a low degree of total dissolved solids (TDS).

Areas underlain by Mabou Group bedrock would be the most likely area for potential supply development.

Windsor Group (Hood Island, Bridgeville and Gays River Formations)

Windsor Group bedrock occurs over approximately the central two-thirds of the proposed RoW. The Group is a complete succession of interstratified evaporates and include two formations within the RoW: interstratified red and green beds of siltstone, limestone, dolostone, gypsum and anhydrite of the Hood Island Formation; and poorly stratified blue-grey to grey-brown anhydrite with scattered beds of light-brown to yellow-brown limestone of the Bridgeville Formation. Siliciclastic breccia, highly fossiliferous limestone and light to dark grey micritic limestone of the Gays River Formation is not known to be located within the study area (Boehner and Giles 1993). However, the formation is in close proximity to the RoW (approximately 600 m to the north) so there is a possibility of it being intercepted.

Only one pumping test was listed for the Windsor Group (Table 5.7). The tranmissivity for this well is 6.7 m^2/day and the well yield is 205 L/min (NSDEL 1973-2001). However, more commonly wells in this Group produce 23 L/min. The water is generally hard and alkaline, and contains a high degree of sulphate and TDS when it has been in contact with gypsum deposits (Maritime Resource Management Service 1975b).

Table 5.7 Summary of Well Water Pumping Test Information, Antigonish County, NS

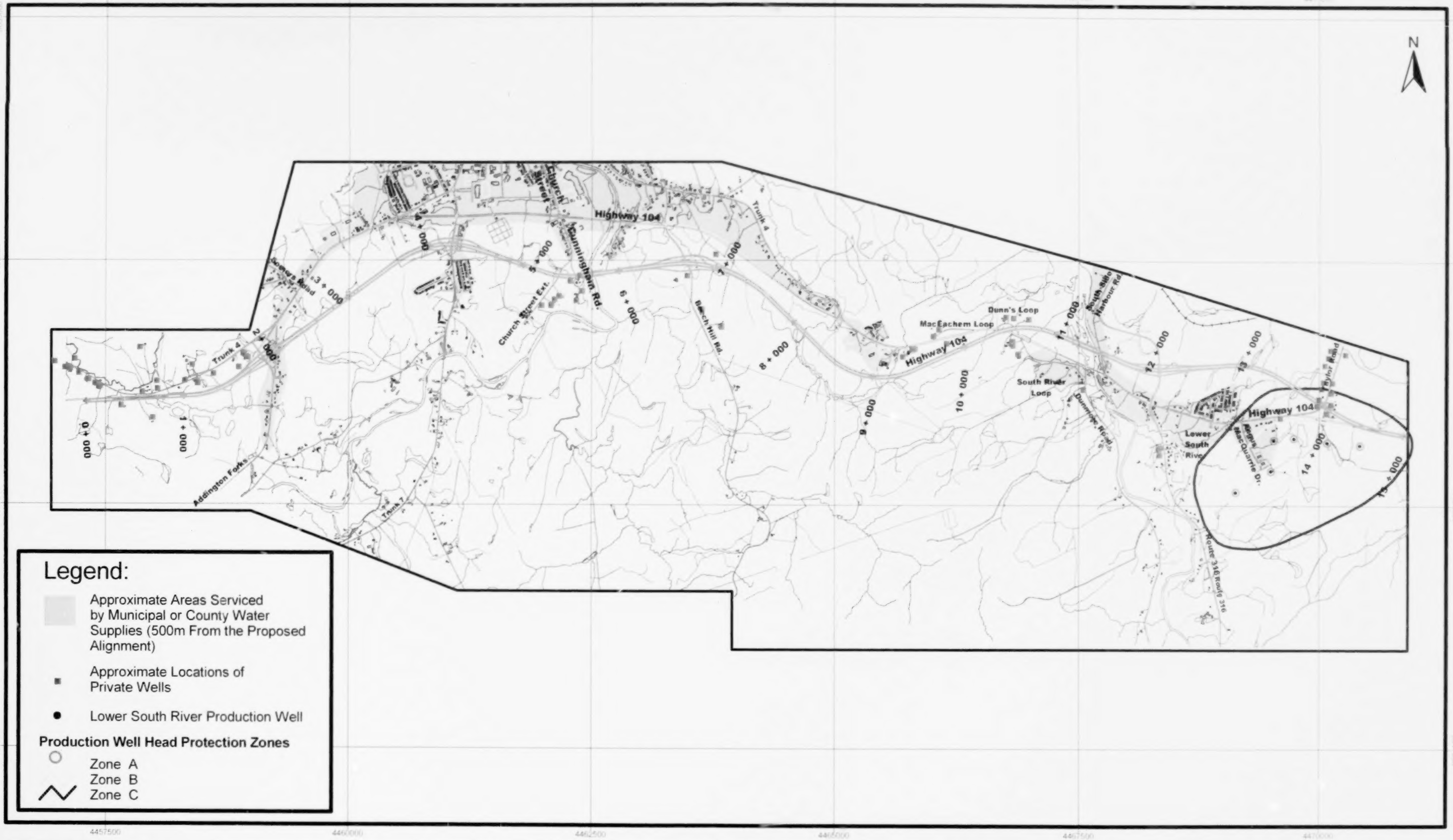
	Well Depth (m)	Well Diameter (m)	Test Hours	Water Level (m)	Pumping Rate (igpm)	Transmissivity (m^2/d)	Specific Capacity ($m^3/d/m$)	Safe Yield (igpm)	Aquifer Transmissivity (m^2/d)	Aquifer Storage Coefficient (units)
Sand and Gravel										
Minimum	3.7	72	3	0	26.4	22.3	69.2	4.2	254.6	0.00033
Maximum	21.3	203	666	4.1	226	1551.5	633.6	1079	1417.3	0.01
Mean	12.3	169.3	97.6	2	132.4	394.6	244.5	314.1	770.6	0.00355
Median	12.2	155	72	1.9	142.5	261.1	161.9	168.8	640	0.00033
Number	12	11	12	12	12	10	10	12	3	3
Mabou (Canso) Group										
Minimum	41.8	155	72	-0.3	3.3	1.1	0.6	3.9	-	-
Maximum	109.7	203	90	29.6	55	21.7	79.9	55	-	-
Mean	60.2	174.2	75	8	27.2	7.4	27.7	24.5	-	-
Median	49.8	155	72	4.1	27.5	4.8	15.2	19.4	-	-
Number	6	5	6	6	6	6	4	6	0	0
Windsor Group										
Value	77.7	155	16	16	45	6.67	9.02	37.3	-	-
Number	1	1	1	1	1	1	1	1	0	0

Source: NSDEL Pumping Test Inventory (1973-2001)

Domestic Water Supply

Six County of Antigonish municipal water supply wells are identified within 500 m of the proposed alignment in Lower South River (Figure 5.3). Three of these wells were included in the Mabou Group pump test summary shown in Table 5.7. The Town of Antigonish's main water supply comes from James River (5 km from the RoW) and two backup wells are located at Rights River flood plain north of the Town of Antigonish (1.6 km from the RoW) and therefore the town water supply is not a concern with respect to this Project. The Municipal Town and County water distribution systems service the majority of the study area. Those areas not supplied by Municipal Town or County water supplies receive water from individual or shared on-site dug or drilled wells. Table 5.8 summarizes the general density and frequency of wells within the proposed alignment along existing roads and highways, and indicates the areas supplied by Municipal Town or County services.

A review of NSTPW mapping and the field reconnaissance indicates that there are up to 62 domestic water supply wells, one non-potable surface water reservoir and six County of Antigonish municipal supply wells located within 500 m of this alignment, predominantly along cross roads, and at the two ends of the alignment. Approximately half of these are distributed along Trunk 4 and Taylor Road at the east and west ends of the alignment, respectively.



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ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Municipal Wellfield and Water Supply Areas

.5 0 .5 1.0 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

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FIGURE 5.3

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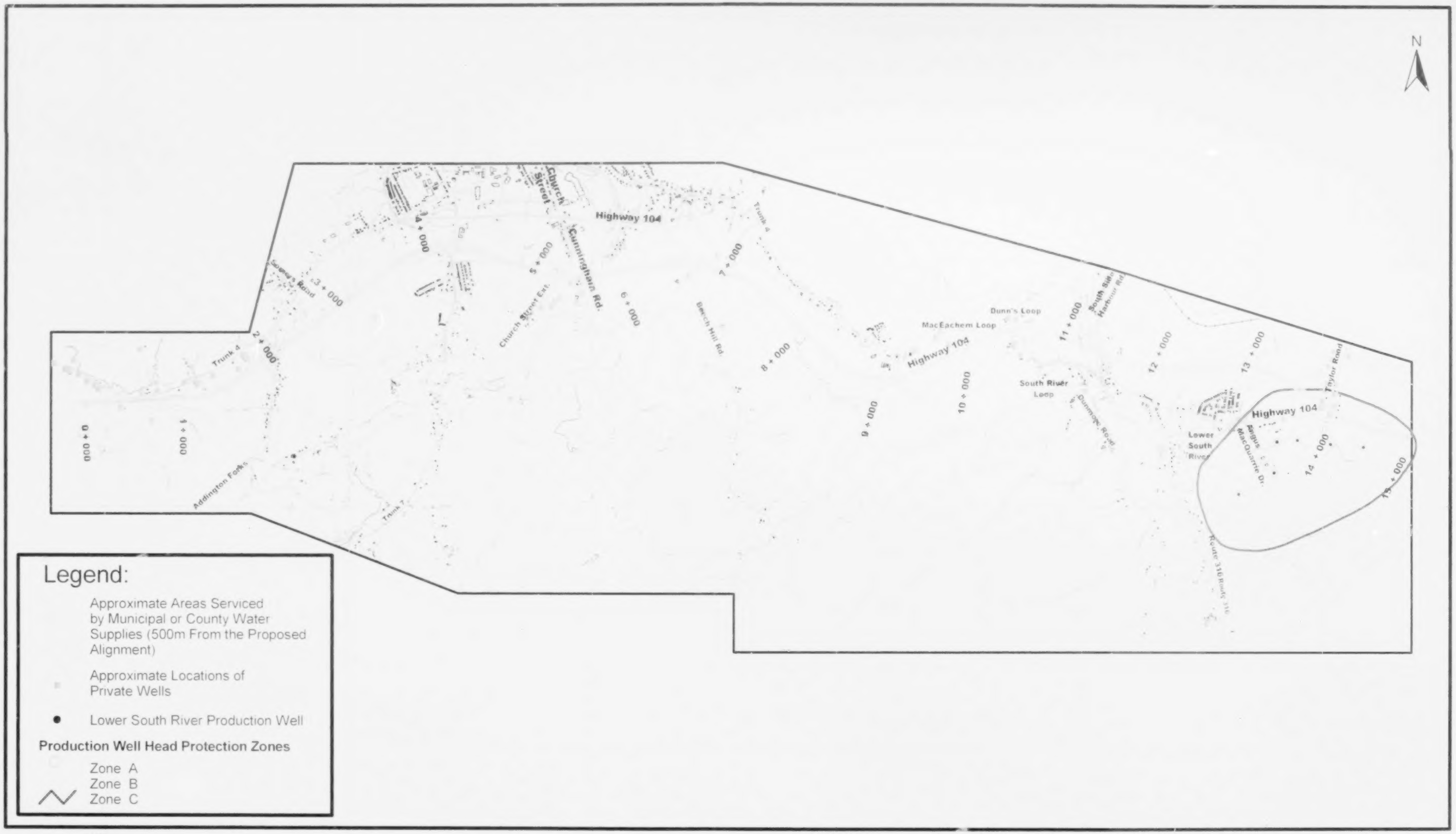

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ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Municipal Wellfield and Water Supply Areas

.5 0 .5 1.0 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

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FIGURE 5.3

Table 5.8 Estimated Number and Type of Domestic Wells within 500 m of the Proposed Highway 104 Alignment

Locations	Chainage	Dug Wells	Drilled Wells	Drilled Municipal Supply Well	Dug Surface Water Reservoirs	Assumed Wells (Unknown)	Water Supplied by Municipal Systems	Total Wells (Including Assumed Wells)
RoW from the Western End of the Alignment to Addington Forks Rd.	0+000 to 1+900							
Existing Highway 104	0+000 to 1+900	0	0	0	0	2	No	2
Trunk 4	1+900	10	5	0	0	5	No	20
Addington Forks Rd.	1+900	0	0	0	0	0	Yes	0
RoW from Addington Forks Rd. to West River	1+900 to 5+700							
Existing Highway 104	North of RoW	0	0	0	0	0	Yes	0
Sommers Rd.	North of RoW	0	0	0	0	0	Yes	0
Town of Antigonish	North of RoW	0	0	0	0	0	Yes	0
Trunk 7	4+200	0	0	0	0	0	Yes	0
Church Street Extension	5+400	3	0	0	0	1	Partial: Existing Highway 104 to Cunningham Rd.	4
Cunningham Rd.	5+550	2	0	0	0	2	No	4
RoW from West River to Beech Hill Rd.	5+700 to 6+700							
Existing Highway 104	North of RoW	0	0	0	0	0	Yes	0
Willowdale Lane	North of RoW	0	0	0	0	0	Yes	0
Beech Hill Rd.	6+700	1	1	0	0	1	Partial: North of Existing Highway 104	3
Beech Hill Rd. to Existing Highway 104	6+700 to 10+400							
Existing Highway 104	North of RoW	3	0	0	1	0	Yes: North Side Partial: South Side	4
Trunk 4	North of RoW	0	0	0	0	0	Yes	0
MacEachern Loop	North of RoW	1	0	0	0	1	No	2
Existing Highway 104 to the Eastern End of the Alignment	10+400 to 14+825.65							
Existing Highway 104	South of RoW	0	2	0	0	0	Yes	2
Dunn's Loop	10+550	0	0	0	0	3	No	3
South River Loop	South of RoW	2	0	0	0	1	Partial: East End	3

Table 5.8 Estimated Number and Type of Domestic Wells within 500 m of the Proposed Highway 104 Alignment

Locations	Chainage	Dug Wells	Drilled Wells	Drilled Municipal Supply Well	Dug Surface Water Reservoirs	Assumed Wells (Unknown)	Water Supplied by Municipal Systems	Total Wells (Including Assumed Wells)
Dunmore Rd.	South of RoW	0	0	0	0	1	Partial: 100 m off Existing Highway 104	1
South Side Harbour Rd.	11+500	0	0	0	0	0	Yes	0
Route 316	South of RoW	2	1	0	0	0	Partial: 100 m Off Existing Highway 104	3
Lower South River Wellfield (Wells and Protected Area)	South of 12+200 to 14+827.65	0	0	6	0	0	County Wellfield	6
Lower South River Mobile Home Park	South of RoW	0	0	0	0	0	Yes	0
Angus MacQuarrie Drive	South of RoW	0	0	0	0	0	Yes	0
Taylor Rd.	13+950	2	8	0	0	2	No	12
Total Wells		**26**	**17**	**6**	**1**	**19**	**N/A**	**69**

5.2.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect is defined as one in which the Project causes one or more of the following:

- yield from an otherwise adequate well supply decreases to the point where it is inadequate for intended use;
- the quality of groundwater from an otherwise adequate well supply deteriorates to the point where it becomes non-potable or cannot meet the Guidelines for Canadian Drinking Water Quality (Health Canada 1999); and/or
- the aquifer is physically or chemically altered to the extent that interaction with local surface water results in stream flow or chemistry changes that adversely affect aquatic life or surface water supply.

A **positive** effect is defined as one on which the quantity or quality of well or spring water is improved as a result of Project activities.

5.2.4 Potential Issues, Interactions and Concerns

A review of NSTPW mapping and the field reconnaissance indicates that there are up to 62 domestic water supply wells, one non-potable surface water reservoir and six County of Antigonish municipal supply wells located within 500 m of this alignment. Approximately half of these are distributed along Trunk 4 and Taylor Road at the east and west ends of the alignment, respectively.

The main issues with respect to impacts on residential water supply wells from highway alignments during various stages include:

- blasting and vibration damages, with consequent temporary siltation (dug and drilled wells) and possible permanent reduction in well yield (drilled wells) during construction;
- aquifer 'beheading', with consequent drop in water levels or loss of yield at dug wells during and after construction (dug well effects);
- accidental releases of fuel chemicals during construction (both types of wells); and
- salt contamination during highway operation (both types of wells).

The potential for well contamination from acidic drainage is considered very low based on the area geology (Section 2.4.12) and is therefore not considered a risk to groundwater supplies.

The severity of these impacts is a function of well type (dug, drilled, spring), age of the well, well construction method (rocked versus crocks; grouting, etc.), distance from the highway, overburden thickness between the highway and the well, and the hydraulic properties of both the overburden and the bedrock. With respect to groundwater quantity, the main concerns related to this project are:

- potential loss of well yield or lowered water level in dug wells during excavation; and
- possible damage to, or loss of drilled wells during blasting operations.

With respect to groundwater quality, the main concerns related to this Project are:

- chemistry changes in down-gradient aquifers or wells due to uncontrolled road runoff near overpasses and interchanges (*i.e.*, salt);
- temporary siltation of dug wells during heavy equipment operations; and
- accidental releases of hazardous materials (*i.e.*, hydrocarbons), up-gradient of a well.

Potential effects and mitigation associated with malfunctions and accidental events are discussed in Section 7.

Preliminary Risk Analysis

The following comments and assessment of potential risk of well damage from this alignment are based on a field reconnaissance survey on October 10 and 11, 2002, published water well information for each area, and the proposed cut and fill operations planned for the RoW (Table 2.1). The survey indicated side roads and access points to the general area of the alignment to identify proximity and type of water supply wells, and also to identify any other constraints such as rock outcrops. No inspection or sampling of wells was done, and no bedrock outcrops were observed. A summary of NSDEL Well Drillers Logs for dug and drilled wells listed for these areas are shown in Tables 5.6 and 5.7 respectively. From west to east along the proposed alignment, observations and comments relevant to each subdivision follows.

Existing Highway 104 (North and South of 0+000 to 14+825.65)

The majority of the existing Highway 104 is serviced by either Municipal Town or County Water with the exception of seven properties with civic addresses on the highway that were either confirmed or suspected of having a drilled or dug well. These properties include: two with drilled wells (Smith & Fraser Homes and Softspray Car Wash (Civic Nos. unknown)); three with dug wells (Civic Nos. 3770, 4278 and one unknown civic number); and two unknown wells at the western end of the alignment (Civic Nos. 2416 and 2448).

The two drilled wells are not likely to be affected by the re-alignment. The dug well at 3770 Highway No. 104 is discussed in the Beech Hill Road (6+700) section, and the unknown wells at 2416 and 2448 Highway No. 104 are discussed in the Trunk 4 (North of 0+000 to 1+900) and Addington Forks Road (0+000 to 1+900) section.

The two dug wells at 4278 Highway No. 104 and Kent Mobile Homes are located north and downgradient of the 9+300 to 9+550 where a filling operation of up to 23 m will take place. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages. The closest dug well will be monitored during construction of the highway and underpass.

County of Antigonish municipal water lines exist in the approximate area of 10+400 where the proposed alignment meets the existing alignment of Highway 104. Construction in this area will plan for the presence of underground services in this area.

Trunk 4 (North of 0+000 to 1+900) and *Addington Forks Road (0+000 to 1+900)*

Eighteen residences or commercial properties on Trunk 4 west of Antigonish and immediately north of the proposed western connection to Highway 104 are served by both drilled wells (Civic Nos. 2376, 2388, 2456 and two unknown civic numbers) and dug wells (Civic Nos. 2354, 2547, 2573, 2647, 2667 and five unknown civic numbers). In addition, the presence of a well could not be confirmed but is suspected at four properties (Civic Nos. 2406, 2428 and two unknown civic numbers). The closest observed drilled and dug wells are approximately 100 m and 50 m north of the RoW, respectively. Two properties within 50 m on the south side of the RoW (Highway 104) could not be accessed during field reconnaissance, but would also have a drilled or dug well.

Seven domestic well logs for this area (Tables 5.9 and 5.10) indicate that dug wells have an average well depth of 6.6 m and a well yield of 568 L/min. Drilled wells had an average depth of 40.4 m, casing length of 28.1 m; well yield of 47.9 L/min (1.1 to 113.6. L/min), and overburden thickness averaging 38.5 m (range 23.0 to 65.6 m), which suggests deep glacial deposits in this vicinity.

The underpass does not involve a major cut (*i.e.*, is not greater than 6 m); therefore the dug wells which are within 50 m down gradient along Trunk 4 are not likely to be dewatered. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent downgradient dug wells to the north of the RoW. The closest dug well will be monitored during construction of the highway and underpass in this area.

Residences along Addington Forks Road within the study area are serviced by Antigonish County water. The proposed underpass must accommodate underground services in this area.

Table 5.9 Summary of Dug Well Information - Proposed Highway 104 Alignment Antigonish

Location	Well Depth (m)	Casing (m)	Diameter (mm)	Est., Yield (L/min)	Water Level (m)	Overburden Thickness (m)
All Wells (Trunk 4)						
Minimum	4.9	4.9	914.4	567.8	3	4.9
Maximum	8.2	8.2	914.4	567.8	4.1	8.2
Mean	6.6	6.6	914.4	567.8	3.5	6.6
Median	6.6	6.6	914.4	567.8	3.5	6.6
Number	2	2	2	1	2	2

Table 5.10 Summary of Drilled Well Information - Proposed Highway 104 Alignment Antigonish

Location	Well Depth (m)	Casing (m)	Diameter (mm)	Est., Yield (L/min)	Water Level (m)	Overburden Thickness (m)
All Wells						
Minimum	16.4	0	0	1.1	-0.3	0
Maximum	122.7	54.1	200	567.8	34.4	67.7
Mean	42.8	19.1	143.5	61.2	10.9	18.2
Median	40.4	19.7	152.4	37.9	9.8	16.4
Number	61	61	61	60	59	61
Residential Drilled Wells in the Vicinity of 0+000 to 1+900						
Minimum	23	13.8	152.4	1.1	-0.3	23
Maximum	65.6	54.1	152.4	113.6	13.1	65.6
Mean	40.4	28.1	152.4	47.9	8.2	38.5
Median	34.4	23.3	152.4	30.3	9.2	25.3
Number	5	5	5	5	5	5
Residential Drilled Wells in the Vicinity of 1+900 to 5+700						
Minimum	16.4	0	101.6	11.4	0.3	0
Maximum	122.7	37.1	152.4	219.6	34.4	32.8
Mean	45.9	18.5	139.7	42.5	16.5	17.6
Median	41.8	22	152.4	28.4	13.5	19.7
Number	16	16	16	16	16	16
Residential Drilled Wells in the Vicinity of 5+700 to 10+400						
Minimum	23.3	6.6	101.6	7.6	4.9	0.7
Maximum	64	36.1	152.4	567.8	32.8	29.5
Mean	42.9	19.2	145.1	98.7	10.6	15.1
Median	41.8	20	152.4	37.9	7.5	18.9
Number	14	14	14	13	13	14
Residential Drilled Wells in the Vicinity of 10+400 to 14+825.65						
Minimum	24.6	6.6	0	7.6	0	1.3
Maximum	72.2	30.8	152.4	151.4	19.7	45.9
Mean	37.8	17.8	136.7	43.2	8.5	13.4
Median	34.4	16.4	152.4	26.5	9.2	9.8
Number	21	21	21	21	21	21

Table 5.10 Summary of Drilled Well Information - Proposed Highway 104 Alignment Antigonish						
Location	**Well Depth (m)**	**Casing (m)**	**Diameter (mm)**	**Est., Yield (L/min)**	**Water Level (m)**	**Overburden Thickness (m)**
County of Antigonish Water Supply Wells (South of 13+000)						
Minimum	41.8	12.2	152	50	-1	4.5
Maximum	67.7	27.4	200	200	10.5	67.7
Mean	55.9	16.9	171.2	113	4.1	29.2
Median	61	13.4	152	90	1.5	26.8
Number	5	5	5	5	5	5
Sources: NSDEL Well Drillers Logs 1969-2000 and C.J. MacLellan & Associates Inc. 2002						

Sommers Road (Northwest of 2+600)

Residences along Sommers Road within the study area are serviced by Antigonish County water. The proposed RoW passes south of Sommers Road.

Town of Antigonish (North of 3+800 to 5+900)

The residential and commercial buildings of the Town of Antigonish are supplied by municipal services. The proposed RoW passes south of the town and does not enter into the town limits.

Trunk 7 (4+200)

Residences along Trunk 7 within the study area are serviced by Antigonish County water. The proposed underpass will plan for underground services in this area.

Church Street Extension (5+400) and Cunningham Road (5+550)

Five residences or commercial properties situated along Church Street Extension and Cunningham Road are served by dug wells (185 Church Street Ext. and two unknown civic numbers, and 280 Cunningham Road and an unknown civic number). In addition, the presence of a well could not be confirmed but is suspected at three properties (155 Church Street Ext., 73 Cunningham Road and one unknown civic number on Cunningham Road). Wells in this area are within 50 m of the RoW. The street is serviced by County water north of the junction of Church Street extension and Cunningham Road. Well logs were not available for this area.

Work at this crossing will involve placement of a service road and discontinuing a portion of Church Street Extension and Cunnington Road. The RoW will pass over top of two wells listed above (dug well at 280 Cunnington Road and the suspected well at the unknown civic number on Cunningham Road and commercial operation). There is also major fill planned for 5+630 to 5+870. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent dug wells.

Willowdale Lane (North of 5+950 to 6+100)

Residences along Willowdale Lane are serviced by Antigonish County water. The proposed RoW passes south of Willowdale Lane.

Beech Hill Road (6+700)

Beech Hill Road is serviced by County of Antigonish municipal services north of the existing Highway 104. South of the existing Highway 104 are three wells within the study area. One drilled well (County of Antigonish building), one dug well (Department of Natural Resources building) and one unknown well. The proposed highway overpass here will have to take into consideration potential for water quality impacts to these wells as well as the dug well at Civic No. 3770 along the current Highway 104.

The work here will involve the placement of up to 9.5 m of fill during the construction of the overpass. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent dug wells.

Trunk 4 (Northeast of 7+000 to 8+300)

Residences along Trunk 4 East of Antigonish are serviced by Antigonish County water. The proposed RoW passes south of Trunk 4 in this location.

MacEachern Loop (North of 9+650 to 10+100)

Two residences and one commercial property are situated along MacEachern Loop. The MacEachern Collision Centre is served by a surface water reservoir. One dug well and one assumed well serve the two residences on MacEachern Loop. These wells are at least 150 m north and downgradient of the proposed RoW so the 11 m deep road cut in this area is not likely to de-water these wells. However, there is risk of temporary siltation of the dug well from vibration during the construction stage. The surface water reservoir is not currently considered potable, so minor degradation of this source is not a significant concern. Well logs were not available for this area.

Dunn's Loop (10+600)

The RoW passes over Dunn's Loop at 10+555. Three residential properties here have unconfirmed wells. Two of the houses owned by Dunn will be within 50 m of the proposed RoW. The third property contains a dilapidated home which may need to be removed during construction. Any well on this property is not currently in use.

The work at this location includes a major road cut up to 18.5 m. If the indicated wells are dug wells, there is risk of de-watering and temporary siltation from vibration during the construction stage. Drilled wells this close to the alignment would be at risk from blasting.

The potential wells in this location will be monitored during construction across Dunn's Loop.

South River Loop (South of 10+650), Dunmore Road (South of 11+350) and Route 316 (South of 12+150)

These roads include partial service by County of Antigonish municipal water, four dug wells (10 and 24 South River Loop, and 4667 and 4669 Route 316), one drilled well (4665 Route 316) and two assumed wells (12 South River Loop and 5285 Dunmore Road). The RoW does not cross these roads but the noted wells are within the study area.

The dug wells along South River Loop are within 50 m upgradient of the RoW, so the proposed 18.5 m deep road cut across Dunn's Loop could result in dewatering of these wells. In addition, there is risk of temporary siltation of the dug wells along South River Loop from vibration during the construction stage. The closest of these wells will be monitored during construction of the highway. The closest wells along Dunmore Road and Route 316 are 200 m and 500 m upgradient of the RoW, respectively, are not expected to be affected by construction of the RoW.

South Side Harbour Road (11+500)

Residences along South Side Harbour Road within the study area are serviced by Antigonish County water. A portion of this road will be discontinued, and relocated, and a highway underpass will be constructed at 12+150.

Lower South River Wellfield Protected Area (South of 12+200 to 14+827.65)

The Lower South River water supply wellfield consists of six production wells. However, information was only available on five of these wells during the preparation of this report. The supply wells have an average depth of 55.9 m, an average casing length of 16.9 m, an average well yield of 113 L/min (50 to 200 L/min), and overburden thickness averaging 29.2 m (range from 4.5 to 67.7 m), which suggests deep glacial deposits in this vicinity. The closest of these wells is within 100 m and upgradient of the RoW which passes through the Zone C protection zone for the wellfield. The location of the wells and protection zone are shown on Figure 5.3.

The Lower South River Wellfield has a well head protection area made up of three protection zones, each with a different level of protection progressively more stringent as the zones move in closer to the wells. The zones were established to roughly correspond with groundwater travel times of three months for Zone A, the closest protection zone, one year for Zone B and twenty-five years for Zone C, the protection zone with the furthest extent (C.J. MacLellan & Associates Inc. 2002). The recommended activity restrictions, or proposed control measures, for each of these zones are shown in Table G.4 in Appendix G. Restrictions are focussed on limiting the storage and use of petroleum fuels and solvents, chlorinated solvents, pesticides, fertilizers to varying degrees within the protection zones. Activities such as sewerage disposal, groundwater production, groundwater heat pumps, forestry development and mining and aggregate removal are also prohibited or limited within these zones.

The proposed RoW passes through Zone C. Because the construction period for the highway in this location is anticipated to be less than one year, impacts to the wellfield are not anticipated from construction activities. Development of associated off-RoW works (*i.e.*, pits and quarries, refuelling areas, disposal areas) will have to consider the proposed wellfield control measures (C.J. MacLellan & Associates Inc. 2002) in this area during construction. Post construction controls for road salting and salt storage in this area will need to be in accordance with the proposed control measures for the wellfield outlined in Table G.4.

Blasting in the area of Taylor Road could damage these wells so ripping techniques will be utilized for bedrock removal (if necessary). Since these wells supply a vast area of the county, they will be monitored during construction of the Route 316 connector between 13+500 to 14+827.65.

Lower South River Mobile Home Park (South of 12+500 to 12+950)

The mobile home park in Lower South River is serviced by Antigonish County municipal water. The proposed RoW passes north of the Mobile Home Park.

Angus MacQuarrie Drive (South of 13+000)

Angus MacQuarrie Drive is serviced by the County of Antigonish municipal water and the RoW passes north of this road.

Taylor Road (13+950)

Nine residences or commercial properties on Taylor Road are served by both drilled (Civic Nos. 8, 21, 47, 59, 65 and three unknown civic numbers (owners: Benoit, Landry and one unknown)) and dug wells (Civic Nos. 59 and unknown (owner: MacPherson)). Note that Civic No. 59 has both a drilled and dug well. In addition, the presence of a well could not be confirmed but is suspected at two properties (Civic Nos. 112 and 139). The RoW passes over three of these properties (Civic Nos. 8, 21 and 47) and both drilled and dug wells will be within 50 m of the RoW.

Nine domestic well logs for this area indicate that drilled wells had an average depth of 34.3 m, casing length of 18.7 m; well yield of 4.4 L/min (1.2 to 12.1. L/min), and overburden thickness averaging 16.5 m (range from 1.2 to 42.7 m), which varied depths of glacial deposits in this vicinity.

A major cut is not planned for the underpass at Taylor Road. However, one of the wells on Taylor Road encountered less than 2 m of overburden. Therefore even a minor cut in this area may encounter bedrock. It should be noted that blasting here could damage drilled wells on Taylor Road close to the RoW. The highway underpass at Taylor Road is also within 100 m of Antigonish County's nearest water supply wells. Work in this area will involve ripping techniques if bedrock removal is necessary. A moderate road cut in this area could de-water dug wells. There is risk of temporary siltation of drilled and dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent dug wells. The nearest dug wells will be monitored during construction.

5.2.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.2.5.1 Construction

The main potential adverse effects on groundwater resources during the construction phase include changes in groundwater quantity or quality in nearby or down-gradient water wells. Physical changes in groundwater flow and quantity may be caused by deep overburden cuts. Changes to groundwater quality could occur due to blasting or ground vibration.

Water Level Lowering

While drilled wells typically exhibit a wide range of deep water table depths depending on location and topography, dug wells completed in dense glacial till or sand and gravel units could have shallower, possibly perched water tables, which would be vulnerable to regional water table lowering caused by a major road cut in thick overburden.

Major excavations though glacial tills could lead to a drop in groundwater table elevation in proximity to the cut. The degree of water level lowering will be proportional to the depth of the cut below natural water table level, the distance between the well and the cut, and the hydraulic properties of the overburden materials (*i.e.,* larger and faster decline in higher permeability sand and gravel than poorly permeable till). Dug wells near the edge of a cut could suffer sufficient water level decline to become dry. These wells are already susceptible to seasonal water level declines of 2 to 4 m in Nova Scotia. Drilled wells are not likely to be adversely affected by overburden cuts.

Major road cuts are expected along the RoW to depths of 7.5 to 18.5 m. There is a risk of aquifer dewatering adjacent to these areas and dug wells in these locations could become dry. In addition, two more likely and less permanent hazards to nearby dug wells are temporary siltation from vibration, or erosion runoff during construction.

Any dug wells located within 50 m of a major highway cut, underpass or overpass will therefore be inspected by the contractor, measured for water level and depth, and inventoried for possible future reference. Dug wells within 50 m are noted along Trunk 4, Church Street Extension, Cunningham Road, Beach Hill Road, Dunns Loop and Taylor Road.

Blasting Effects

Blasting can cause effects in adjacent wells ranging from minor temporary turbidity to rare complete collapse of the well. Wells completed within 500 m of the proposed RoW could theoretically be affected to some degree. Severity of effect is proportional to distance, physical and seismic properties of the bedrock being excavated, age and construction method of the well, well yield, and blast magnitude. Other mitigating factors include thick overburden and 'soft' bedrock. Based on 61 drilled well logs (Table 5.7) the median overburden thickness is 16.4 m, which implies a low probability of encountering bedrock. The bedrock is comprised of relatively 'soft' sandstone, mudstone, and limestone which should require much less blasting energy to excavate than other areas of Nova Scotia.

A significant amount of the alignment passes through populated areas. Assuming careful attention to the possible bedrock cuts, blasting damage risk to water wells and critical aquifers is considered to be low except in the area of the Lower South River Wellfield where damage to a supply well would be more problematic. Ripping techniques will be used where possible in lieu of blasting, in proximity (*i.e.*, within 500 m) to residential water wells and at the eastern end of the alignment in the vicinity of the County of Antigonish Lower South River Wellfield. Development of associated off-RoW works *i.e.*, pits and quarries, refuelling areas, disposal areas will have to consider the proposed wellfield control measures (Appendix G) (CJ MacLellan & Associates Inc. 2002) in this area.

5.2.5.2 Operation and Maintenance

The main potential adverse effects on groundwater resources during the operation and maintenance phase of the Project include changes in groundwater quality due to road-runoff *(i.e.,* salt), and accidental spills of hazardous substances on the highway. The areas of clay and silt (low permeability overburden cover) and drainage of salt laden runoff away from nearby wells along ditching will likely mitigate this effect on wells. However, the area most likely to be affected may be areas underlain by highly permeable sand and gravel overburden in the vicinity of the west end of the alignment (Trunk 4) and Lower South River as well as the Antigonish County Wellfield. Post construction controls for road salting and salt storage in this area will have to be in accordance with the proposed control measures for the wellfield outlined in Table G.4.

5.2.6 Follow-Up and Monitoring

Several wells are located within the 500 m assessment boundary, particularly where the alignment crosses existing roads. NSTPW's Construction Contractor will complete an inventory of residential water wells. This would include an interview of the well owner, documentation of well construction specifics, collection of a water sample for chemical and bacteria analysis, and photographic documentation of the well location. Appendix G presents a typical procedure for a pre-construction residential well survey. A contingency plan will also be developed for the area of the wellfield protection zones to ensure that any potential malfunctions or accidental events are addressed appropriately and in a timely manner to minimize potential impacts to the wellfield that could arise from highway operations.

In the event that any residential wells are found within 500 m of any blasting excavation areas (road cut or quarry), or if dug wells are located within 50 m of a major (> 5 m) overburden cut, these wells will be inspected (measuring depth, yield and water level in dug wells), and sampled for baseline water quality (Rcap-MS and bacteria). Where several drilled wells are present within the proposed 500 m blast monitoring radius, selected representative proximal wells will be inspected, baseline sampled, and closely monitored during the construction phase. The Contractor will implement a contingency plan to provide temporary water during construction, and to repair or replace any wells found to be permanently damaged, in the event that wells are adversely or permanently affected by the Project.

Because water levels may change slowly over time in tight glacial till aquifers, follow-up water level monitoring is proposed for shallow dug wells located close to major overburden cuts along the alignment. Natural seasonal variation in water levels will be considered in the evaluation of effects. The suggested duration of any post-construction monitoring would be the lesser of two years of quarterly monitoring, or stabilization of water level or chemical indicators in wells of concern.

5.2.7 Summary of Residual Environmental Effects Assessment

Provided the proposed mitigative measures are implemented, no significant adverse residual environmental effects on groundwater resources are likely to occur. Possible increases in sodium and chloride concentration in wells in close proximity and downgradient of the proposed highway is the most likely potential effect, although this effect is not considered to be significant. Tables 5.11 and 5.12 provide a summary of the residual environmental effects assessment for groundwater resources.

Mitigation measures during highway operation include remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed. Drainage controls (*e.g.*, ditching) may be applied as needed to divert salt or contaminant laden run-off away from potentially affected wells.

Table 5.11 Residual Environmental Effects Assessment Matrix Groundwater Resources (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Blasting	• Loss of well yield (A)	• Avoidance of blasting to the extent possible within 500 m of residential wells and the Lower South River wellfield; use ripping techniques where possible • Pre-blast survey • Remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed	1	3	2 / 1	R	2	N	3
Excavation	• Water level lowering in shallow dug or drilled wells (A) • Temporary siltation (A)	• Monitoring and remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed	1	3	2 / 1	R	2	N	3

KEY

Magnitude: 1 = Low: i.e., temporary localized effects on aquifer that do not adversely affect well users; 2 = Medium: i.e., temporary effects on aquifer to adversely affect water wells, require treatment or modification of wells; 3 = High: i.e., permanent damage to aquifer supplying wells or interacting with surface water resources, well water supplies need to be replaced

Geographic Extent: 1 = <500 m^2; 2 = 500 m^2 -1 km^2; 3 = 1-10 km^2; 4 = 11-100 km^2; 5 = 101-1000 km^2; 6 = >1000 km^2

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

Table 5.12 Residual Environmental Effects Assessment Matrix Groundwater (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Road De-Icing	• Water quality degradation (A)	• Remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed • Apply drainage controls	2	4	2 / 1	R	2	N	3
Road Repairs	• Water quality degradation; siltation (A)	• Drainage and vibration controls • Remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed	1	4	2 / 1	R	2	N	3

Refer to Table 5.11 for Key.

5.3 Fish and Fish Habitat

Fish and fish habitat is included as a VEC because suitable fish habitat is of vital importance to Nova Scotia's fish populations. Chemical, physical and biological factors are variables that determine a stream's suitability as fish habitat. The proposed RoW crosses16 watercourses located in the Antigonish area. The proposed South River crossing was evaluated in a separate impact study (Neill and Gunter Ltd. 2001). The results are incorporated in this section and the impact study is appended to this report (Appendix E). Fish and fish habitat are protected by federal legislation and are vital, dynamic components of a healthy ecosystem. Water quality in the watercourses is also discussed in the context of this VEC since the quality of the water directly affects the quality of the aquatic habitat.

5.3.1 Boundaries

The spatial boundaries for this VEC include all streams crossed by the proposed RoW, and receiving and terminating waterbodies, that potentially influence stream dynamics or provide or enhance fish habitat. Standard procedures include assessing fish habitat 100 m downstream and 250 m upstream of the proposed crossing which, coupled with stream site information, provides baseline information for subsequent habitat evaluations and monitoring.

Temporal boundaries for the assessment includes the construction and operation phases of the Project, focussing on periods of greater fish sensitivity such as fall spawning, the emergence and success of fry in the spring, and potentially high stress periods in low-water summer conditions.

5.3.2 Description of Existing Conditions

5.3.2.1 Fish and Fish Habitat

DFO Information

Of the watercourse crossings along the proposed RoW, there are significant watercourses and wetlands which have been identified as having particular significance to salmonid and other species. DFO has twice reviewed the study area for the proposed Highway 104 and identified several concerns. In response to the environmental screening and the *Federal Coordination Regulations* process, letters from both Charles MacInnis and James Leadbetter (DFO) were received by NSTPW, in February 1997 and October 2001. These letters highlighted concerns with regard to potential impacts on Brierly Brook, West River, and South River. Concern was also expressed regarding the erodible soils found in the study area and potential changes to the hydraulic regimes.

Brierly Brook was noted as having been the focus of a highly successful five-year project geared toward restoration of spawning and rearing habitats for Atlantic salmon and brook trout. The result has been an eightfold increase in salmon spawning in the brook since 1992.

The West River was noted as having the highest juvenile Atlantic salmon densities per unit area of any watershed in the Maritimes and has also undergone habitat restoration work. The proposed crossing site is a critical migration route and holding area. Site specific concerns DFO had with the crossing of West River were: ice jamming at the proposed bridge location with associated bank and bottom substrate scouring; sedimentation from sub-grade; and interference with existing fisheries.

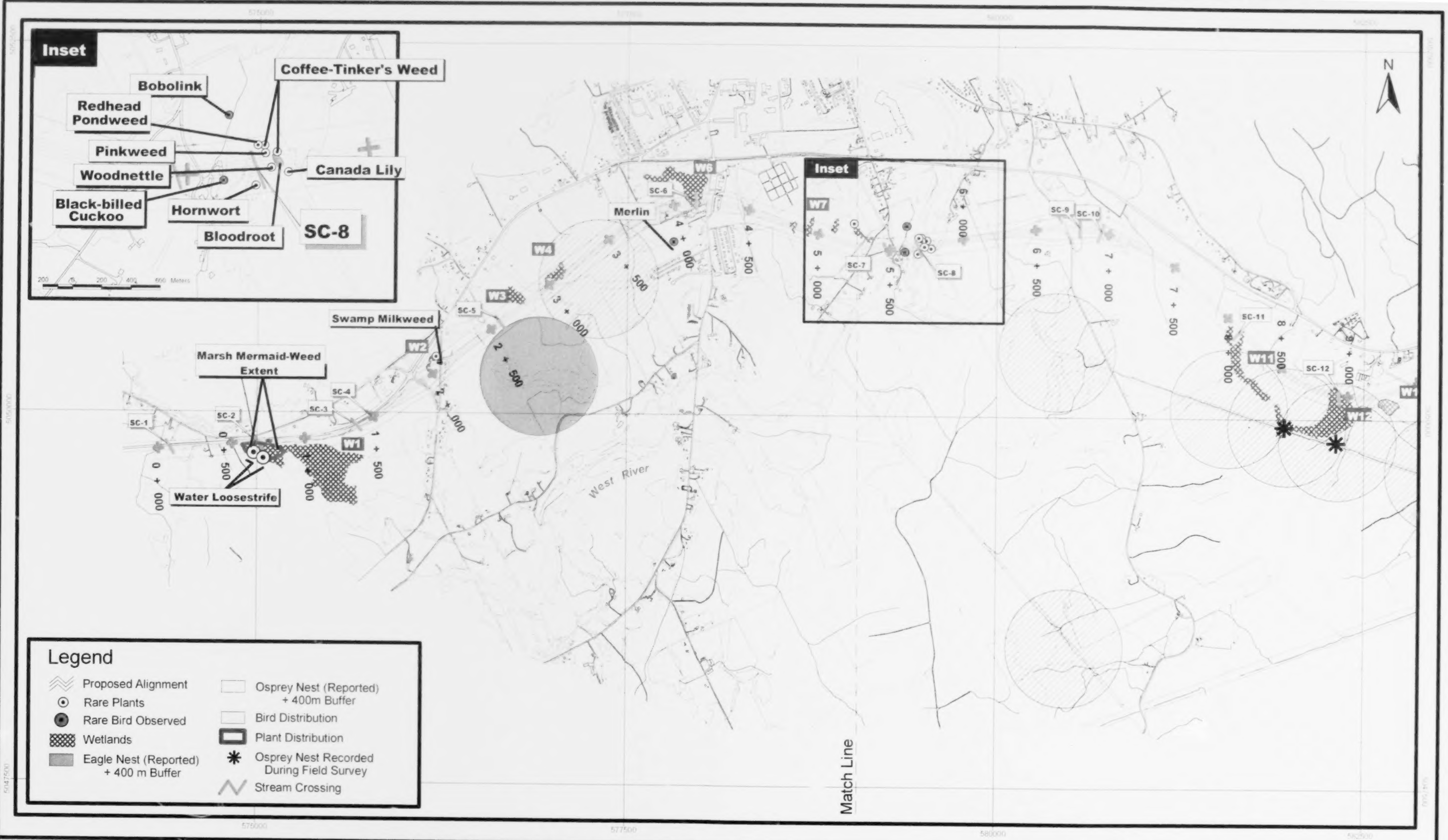
The South River was noted for the diversified fish population it contains including Atlantic salmon, sea trout, brown trout, rainbow trout, striped bass and gaspereau. The area of the river north of the existing highway crossing is a highly productive salt marsh, critical to marine and freshwater fisheries resource. DFO required a detailed assessment for this crossing, which was undertaken by NSTPW (Neill and Gunter Ltd. 2001).

Also of concern, are two wetlands potentially impacted by the proposed highway. One is located at 1+000 while the other one is located at 4+150 (at Trunk 7). The concerns associated with the construction of the highway would be the loss of overwintering habitat at the 4+150 wetland and potential impacts to the lower parts of the tributaries and Brierly Brook, into which both wetlands drain. These wetlands are described in Section 5.8.

The nature of the soils and the rolling terrain adjacent to the proposed watercourse crossings greatly increase the potential for adverse effects on the fisheries resource during construction of the highway. One last concern identified was hydraulic changes to the streams. The tributaries and ditches located downgradient of the alignment will have to be stabilized in order to account for higher flows as a result of road construction to prevent scour and increased sediment loading downstream.

Methodology

Based on existing 1:20,000 NTS mapping and 1:10,000 air photos, 30 potential watercourse crossings were identified. In walking the length of the proposed highway route, the field crew found sixteen crossings, including South River (Figure 5.4). Due to low water levels at the time of the survey (June 24, 2002), electrofishing was possible at only four watercourses, three of which were found to contain fish. Although water levels were low at the time of the survey, only four of the eleven dry streams would, at times of normal or high water, be considered fish habitat. The area surveyed revealed a number of streams with negligible flow where electrofishing was not possible due to fish safety parameters. Despite low water and a lack of data for species composition of some of the brooks, this assessment considered the seasonal dynamics of the watercourses and the life history of the species present. Despite dry conditions, the habitat was also



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Jacques Whitford

NOVA SCOTIA
Transportation and Public Works

SCALE: 1 : 37 500
Date: 9/01/2004
Drawn By: GM
Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

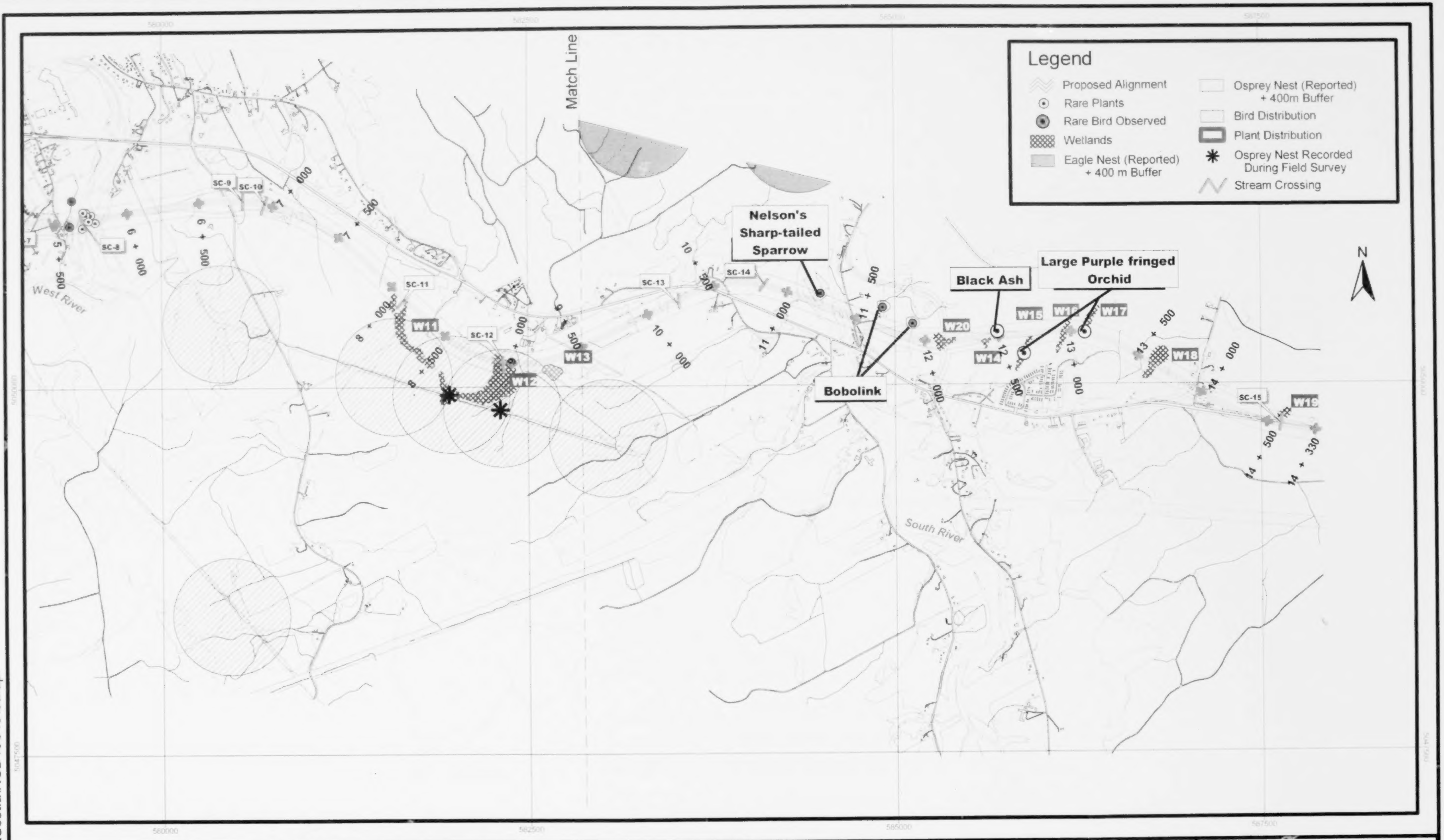
ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Biophysical Features (West)

0.5 0 0.5 1 1.5 Km

Map Parameters: UTM, NAD27, Zone 20

DRAWING NO.
NSD16949
FIGURE 5.4a



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NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Biophysical Features (East)

0.5 0 0.5 1 1.5 Km

Map Parameters: UTM, NAD27, Zone 20

DRAWING NO.
NSD16949
FIGURE 5.4b

evaluated as it would be during conditions of normal flow taking into consideration channel width, wet width and stream substrate. Minnow traps were set for the South River study (September 29, 2000) and the river was also found to contain fish (refer to Appendix E).

Information collected to complete the assessment is not limited to field survey (*e.g.*, electrofishing) data but also includes input from a variety of sources. It is necessary to consult various sources as stream flow, despite rainfall amounts being at 87% of maximum rainfall for the season at the time of the survey (Environment Canada 2003), is naturally low in some of these watercourses which excludes electrofishing. While all stream crossings are visited during the survey, interviews conducted with DFO prior to the field survey identified streams with fish habitat potential and the types of fish recorded in these watercourses. Other sources of information include local and aboriginal recreational fishers, special interest groups and existing background information.

Preliminary evaluations of the proposed watercourse crossings were based on 1:20,000 mapping and 1:10,000 air photos. Consistent with the standard approach used in Nova Scotia, habitat characterizations at potential watercourse crossings were conducted 250 m upstream and 100 m downstream of the proposed RoW centreline. The South River survey was conducted the week of September 29, 2000, under separate contract, and the balance of crossings were surveyed during the week of June 24, 2002 by a qualified aquatic biologist and two field technicians. Combinations of stream flow, water depth, and substrate are major determinants of the quality of fish habitat for rearing and spawning. The aquatic habitat characterization included identification of the physical units (*i.e.*, riffles, pools, runs), instream cover, substrate composition, stream depth and width, water velocity, overhead cover, and water colouration. To assess water quality, water samples were collected during the fish habitat surveys. Collected water samples were analysed for general chemistry parameters and trace metals. Results of water quality analysis are presented in Appendix D. The results of salinity, conductivity and temperature measurements taken at the South River crossing are included in Appendix E of the impact study (refer to Appendix E of this report).

Much of the discussion of fish habitat is focussed on salmonids (*i.e.*, trout, salmon) due to their societal value. Rearing and spawning habitat for salmonids along the proposed route was classified using a rating scale. Five general categories are used to differentiate predominant salmonid habitat. These categories are based on quality of substrate, water flow, and stream morphology as follows:

Type 1:	Good salmonid spawning and rearing habitat
Type 2:	Good salmonid rearing habitat with limited spawning, usually only in small, isolated gravel pockets
Type 3:	Good rearing habitat with no spawning capabilities, or used for migratory purposes
Type 4:	Poor juvenile salmonid rearing habitat with no spawning capability; may provide shelter for older salmonids
Type 5:	No habitat available for rearing or spawning; usually too steep for fish access or intermittent streams.

The location of each proposed watercourse crossing is presented on Figure 5.4. Habitat summaries for each proposed stream crossing are presented below. Appendix D contains a detailed description of habitat and related habitat mapping, and includes information on stream bank slopes and erosion potential. Appendix B contains the hydrotechnical evaluation of the proposed highway. Appendix E contains the South River Impact Study (Neill and Gunter Ltd. 2001).

Habitat Summaries

Unnamed Tributary to Brierly (Stream Crossing No. 1) 0+100

This unnamed tributary to Brierly Brook is an intermittent headwater stream that had a channel width of 100 cm. No water was flowing through the brook at the time of the survey. The depth of a pool situated upstream of the culvert underneath Highway 104 measured 12 cm. At the time of survey the upstream habitat included a series of riffle areas with no flow. The RoW is located upstream of the existing Highway 104. After the brook crosses the highway in a box culvert, the channel is ill defined. Upstream substrate was composed of gravel and cobble while the substrate downstream of the RoW was composed of organic and silts. Embeddedness was high (>50 %) (embeddedness being defined as the degree that gravel and larger particles are surrounded or covered by fine sediment). The riparian vegetation was dominated by black spruce, sphagnum moss and brackenfern upstream and downstream of the RoW, while sedges and rushes dominated the banks of the stream at the RoW. Water temperature was 14°C, and had a pH reading of 6.7. Overall erosion sensitivity levels varied from moderate-low to moderate. These levels are based on particle size/class/ texture of sample collected 10 cm deep, 5 m from stream bank.

No fish were observed in Stream Crossing No. 1, and the crossing was rated as a Type 5 salmonid habitat for reasons such as its lack of flow, silty downstream substrate, and small size. In periods of high water this tributary may have flow, but it is unlikely that it is ever used extensively by any fish species as there is no defined channel downstream of the RoW. However, this brook flows into Brierly Brook which is a salmonid bearing stream.

Unnamed Tributary to Brierly Brook (Stream Crossing No. 2) 0+800

This unnamed tributary had an average channel width of 4.04 m at the RoW. Upstream of the RoW, the stream becomes an extensive marshy area. Downstream of the RoW, the stream flows along Highway 104 and flows into a culvert underneath the highway. Mean depth of the channel at the RoW was 40 cm. The substrate was composed of 100 % silt and therefore embeddedness was high at the RoW and upstream of the RoW while it was moderate (20-35 %) downstream of the highway. Bank vegetation contained grasses, cattails and water horsetail. Water temperature was 15.9°C and a pH of 5.54.

This stream is likely Type 3 salmonid habitat based on morphology, substrate and habitat characteristics. Electrofishing was attempted at the culvert but no specimens were obtained. Poor footing and heavy vegetative cover limited electrofishing access in the marsh area located upstream of the ROW. The banks are natural and contain a sandy-silty soil, based on textural of soil samples collected approximately 5 m from the edge of the stream, at a depth of approximately 10 cm. Overall erosion sensitivity of the banks was low on the left bank (looking downstream) and high on the right bank.

Unnamed Tributary to Brierly Brook (Stream Crossing No. 3) 1+400

This headwater tributary flows into the brook associated with Stream Crossing No. 2. No water was flowing in the brook except for a pool located downstream of a culvert underneath Highway 104. This brook had no defined channel at the RoW at the time of the survey . The substrate at the RoW was composed of 100 % silt. Embededdness was high (> 50 %) at the proposed crossing. The brook sprawled upstream of the RoW, becoming undefined and difficult to follow, and preventing further assessment of stream criteria. Downstream of the RoW, the brook regains a defined channel and substrate was composed of sand, gravel and a few cobbles. Bank vegetation contained cattails, rushed and grey alders. Water temperature was 16.4°C and a pH of 6.8. Overall erosion sensitivity levels were moderate.

Electrofishing was not possible on this stream due to limited morphological dimensions of the stream and lack of water at the time of the survey. Due to morphology and habitat characteristics this brook is rated as Type 5 salmonid habitat.

Unnamed Tributary to Brierly Brook (Stream Crossing No. 4) 1+500

This headwater tributary also flows into the brook associated with Stream Crossing No. 2. This unnamed tributary was dry at the time of the survey except for a pool of water located downstream of the culvert underneath Highway 104. The substrate was mostly silt and organic matter at the proposed crossing and upstream, with sand and gravel upstream. Embeddedness was high (> 50%) both upstream and downstream. Bank vegetation contained gramminoid spp., buttercups, water horsetails and grey alders. Water temperature was 16°C and a pH of 6. Overall erosion sensitivity levels were moderate.

As with Stream Crossing No. 3, electrofishing was not possible on this stream due to limited morphological dimensions of the stream and lack of water at the time of the survey. Due to morphology and habitat characteristics this brook is rated as Type 3 salmonid habitat.

Unnamed Tributary to West River (Stream Crossing No. 5) 2+600

Stream Crossing No. 5 had an average wet width of 0.6 m and a channel width of 1.5 m. The substrate was composed of boulders and rubble. Embededdness was moderate (20-35 %) at the proposed crossing and both upstream and downstream. Bank vegetation contained black spruce, grey alders, club moss, sensitive ferns. Water temperature was 12.2°C and a pH of 6.6. Overall erosion sensitivity levels were moderate-low and moderate-high. Flow was negligible and not calculable, due to low water levels.

No fish were observed at Stream Crossing No. 5 and it is rated as Type 3 salmonid habitat. No electrofishing was conducted due to lack of water. At times of high water, this stream would probably be unsuitable as salmonid spawning habitat. However some salmonid may migrate through this stream into the West River which has a well known salmonid population.

Unnamed Tributary (Stream Crossing No. 6) 4+150

Stream Crossing No. 6 was a pool of standing water at the time of the survey . It had a mean channel width of 25 cm. The substrate was composed mostly of silt. The substrate contained gravel and cobbles upstream of the RoW while the substrate remained silty downstream of the RoW. Bank vegetation was composed of bracken ferns, gramminoid, grey alders and club moss. Embededdness was high both at the proposed crossing and downstream (50 %), but was moderate upstream (20-35 %). Bank vegetation contained gramminoid spp., sensitive ferns and grey alders. Water temperature was 15°C and a pH of 6.5. Overall erosion sensitivity levels were low.

Stream Crossing No. 6 is rated as Type 4 salmonid habitat. One nine-spine and four three-spine sticklebacks were caught during electrofishing at this crossing.

Unnamed Tributary of West River (Stream Crossing No. 7) 5+500

This unnamed headwater tributary contained little water in pools located on the RoW. It had a mean wet channel width of 0.85 m channel width of 1.45 m. The substrate at the RoW was composed of silt while 100 m downstream the substrate is composed of cobbles and a few boulders as the slope of the stream channel is increased. Bank vegetation was composed of grey alders and thistle. Embededdness was high both at the proposed crossing and upstream (>50 %), but was low downstream (<20 %) . Water temperature was 16.1°C and a pH of 7.1. Overall erosion sensitivity levels were low.

Salmonid habitat at the crossing site was marginal but this brook is considered Type 3 habitat.

West River (Stream Crossing No. 8) 5+700

West River had an average wet widths at the RoW of 24 m and a channel width of 29 m. The average depth was 30 cm at the time of the survey. The habitat included riffles, runs, and a few deep pools. The substrate is predominantly cobble with smaller amounts of boulder and gravel. Embededdness was low (0-20%). Flow is approximately 4.39 m^3/s. The water had a pH of 5.85, a temperature of 15.7°C and was colourless.

Bank vegetation included gramminoids and alders. Overall erosion sensitivity levels were moderate to moderate-high.

Stream crossing No. 8 is rated as Type 1 salmonid habitat since it is one of Nova Scotia's premier fall season salmon recreational fishery rivers. Nine-spine stickleback, three-spine stickleback, creek chub, northern red-belly dace, banded killifish, white sucker and Atlantic salmon were caught in West River during the electrofishing survey. Brook trout and brown trout also inhabit the system.

Unnamed Tributary to West River (Stream Crossing No. 9) 6+750

This unnamed headwater tributary of the West River had an average channel width of 1.5 m upstream. No water was flowing at the time of the survey and mean depth of a pool of standing water was 3 cm. The habitat types present included riffles, runs, and pools. The substrate is predominantly cobble, with some sand and boulders. At the RoW, the channel runs in a channel 2-3 m lower than the forest floor creating steep banks on each side of the channel. The water was clear, with a pH of 6.88 and temperature of 13.6°C. Overall erosion sensitivity levels were moderate-high to high. Embeddedness was approximately 25 %, upstream and downstream of the RoW. Black spruce, ferns and mosses dominated the bank vegetation.

Stream Crossing No. 9 is rated as Type 5 salmonid habitat. This tributary is intermittent and probably only flows after rain events for a short duration. A poorly designed culvert is situated 70 m downstream of the RoW and at the time of the survey was completely blocked off by vegetation.

Unnamed Tributary to West River (Stream Crossing No. 10) 6+950

This unnamed headwater tributary of the West River was completely covered by wood debris from a previous logging operation in the area. No riparian vegetation was left from 40 m downstream of the RoW to 100 m upstream. No water was flowing at the time of the survey. Channel width was approximately 1 to 1.5 m wide. Downstream of the logged zone, the habitat includes runs, riffles, and pools. The substrate is mostly of cobble and gravel, with smaller amounts of sand. The water had a pH of 7.2, a temperature of 16°C and was colourless. Embeddedness was high at the RoW (>50 %) and erosion sensitivity was rated as moderate-high on both sides of the ROW. There are steep slopes on the right and left bank of this stream.

Stream Crossing No. 10 is rated as Type 4 salmonid habitat. In times of greater discharge, this stream could potentially provide marginal habitat for salmonid species, especially if the logging slash was removed from the streambed. However, the section of stream affected by the RoW does not have any remaining bank vegetation and it is probable that the stream temperature will increase and become inhospitable to salmonid species.

Unnamed Tributary to West River (Stream Crossing No. 11) 8+150

This unnamed tributary had a channel width of approximately 15 m at the RoW due to a beaver dam located 40 m downstream of the RoW. The substrate was composed of 100% organic matter and silt. Embeddedness was high (>50 %) and erosion sensitivity was rated as moderate-high and low-moderate. Bank vegetation and approaching slopes have been logged extensively and few mature trees are left. Water temperature had a pH of 6.38, a temperature of 18.6°C and a brown colour.

Electrofishing was conducted downstream of the RoW in several morphological features (riffles, pools and runs). During electrofishing, it was noted that loss of habitat had occurred because of the increased sediment loads in the stream. It is probable that the increase of sediment in the stream is a direct result of the loss of riparian vegetation along the stream. Stickleback and cyprinide species were caught in the electrofishing survey, however no brook trout were caught in the stream section electrofished. This is probably due to the increased water temperature and lower dissolved oxygen levels in that section. In areas with less human disturbance and groundwater discharge, it is probable that this stream affords good fish habitat and would be rated Type 2.

Unnamed Stream (Stream Crossing No. 12) 9+000

This portion of the stream was very difficult to distinguish as there was no defined stream channel but just a few pools of standing water dispersed in the area. The area showed signs of logging activities in the last ten years as most of the vegetation is considered early successional. The pool located at the RoW had a wet width of 1.1 m and a channel width of 1.4 m. Bank vegetation was composed of gray alders, gramminoids, raspberry and cattails. The water had a pH of 6.8, a water temperature of 19.3°C and was yellow-brown in colour. Embeddedness was high (>50%) and erosion sensitivity levels were classified as low-moderate for both banks. The major component of the substrate was silt.

Stream Crossing No. 12 is rated as Type 5 salmonid habitat. This stream was not electrofished due to lack of water and high water temperature. No fish were observed during the survey.

Unnamed Tributary to South River (Stream Crossing No. 13) 10+200

This headwater stream had no water flowing in the time of the survey. Approximately 40 m downstream of the RoW, a culvert is located underneath the old portion of the highway. This culvert is not well designed as it plunges approximately 1 m from the upstream streambed into the culvert. The substrate was predominantly boulder and cobble. Embeddedness was relatively low (0-20 %) at the RoW. Bank vegetation at the RoW consisted of black spruce, choke berry and grey alders. Erosion sensitivity levels were rated as high on the left bank and moderate on the right bank.

Although this brook was dry at the time of survey this brook it is certainly a Type 5 salmonid habitat when flows are normal or high. The poorly designed culvert downstream of the RoW impedes fish passage which makes it a candidate for habitat compensation.

Unnamed Tributary to South River (Stream Crossing No. 14) 10+850

This watercourse could be described as a drainage ditch as it runs parallel to a field. At the time of the survey there was no water flowing into the tributary and terrestrial vegetation had invaded the streambed. This watercourse had an average channel width of 1.5 m at the proposed crossing. The substrate was predominantly silt and organic matter. The watercourse is overgrown by grasses and cattails. The banks are composed of silty and sandy topsoil and have an erosion sensitivity level rated as high and high-very high. This watercourse probably does not provide fish habitat at any time of the year and is rated as Type 5 salmonid habitat.

Unnamed Stream (Stream Crossing No. 15) 14+600

This unnamed stream had an average channel width of 1.5 m and a mean depth of 3 cm at the proposed crossing. This stream is parallel to the existing highway and crosses underneath the highway in a culvert. The substrate was composed predominantly of silt. It is rated as Type 5 salmonid habitat.

South River Crossing 11+100

Aquatic habitat consists of the river channel to the east, a backwater channel entering the island area from the north and a backwater channel to the west. Since construction of the existing crossing, backwater channel has accumulated a 10 cm layer of organic/silt deposits over an original substrate of medium to fine gravel (Neill and Gunter Ltd. 2001). Water depths vary between 0.3 m and 2 m at near tide.

During the survey, temperatures in the channels ranged from 16°C to 20°C, conductivity ranged from 0.4 millimohs (mmohs) to 27 mmohs and salinity ranged from 0.1 parts per thousand (ppt) to 18 ppt. Minnow traps set during the survey yielded mummichogs and a white sucker.

Summary

Seven of the 15 stream crossings evaluated in 2002 were rated by the field crew as Type 5 with no habitat available for rearing or spawning for reasons such as lack of flow, silty substrate and banks that contain silty or gravelly sandy topsoil. Steam Crossings No. 4, 6, 7 and 10 were rated as Type 4 habitat, poor spawning/rearing habitat but providing shelter for older salmonids. Two streams were rated as Type 3 habitat while one stream crossing was rated as Type 2 habitat, which is described as good salmonid rearing habitat with limited spawning capacity. West River was the only stream rated as a Type 1 salmonid habitat. Despite low flow conditions encountered at the time of the survey, the study team is confident that the habitat evaluations are applicable to average conditions throughout the year.

The South River evaluation found that the main and back channels are equally productive in terms of fish habitat; however, the primary function of the crossing area is fish passage, as spawning habitat is not present for game species such as brook trout, brown trout and Atlantic salmon at this site.

5.3.2.2 Water Quality

Four rounds of surface water sampling were conducted on watercourse crossings along the proposed highway RoW. The first sampling event occurred in June 2002, the second in October 2002, the third in February 2003 and the final sampling event was conducted in April 2003. Surface water sampling was conducted at the South River crossing in October 2000.

South River Crossing

Water quality parameters investigated during the South River Impact Study (October 5, 2000) included salinity, conductivity and temperature. Salinity ranged from 0.1 ppt to 18 ppt while conductivity ranged from 0.4 mmohs to 27 mmohs. Temperature ranged from 16°C to 20°C. Salinity and conductivity results were consistent with brackish water indicating that the area is an intertidal zone.

June 2002 Sampling Event

Water quality chemistry results are included in Appendix D. Three of the crossings (12, 13 and 14) did not contain water at the time of the survey. Of the 15 parameters listed in the Freshwater Aquatic Life (FWAL) Guidelines (CCME 1999), analytical results indicated exceedances of five metals, namely copper, lead, chromium, iron and aluminum. While some of these exceedances may be attributable to natural rock weathering, elevated metals concentration in surface water can also be attributed to anthropogenic (human) sources (especially coal burning).

The current guideline for copper is 2 μg/L, and 92 % of the samples had copper levels higher than the CCME guideline. Lead concentrations exceeded the CCME guideline in 42% of the samples while chromium concentrations exceeded the guidelines in 25 % of the samples obtained in the June survey. Maltby *et al.* (1995) recognised that deicing salts can contribute chromium and copper to streams.

For the protection of freshwater aquatic life, the concentration guideline for iron is 300 μg/L. Elevated concentrations of iron were detected in 66% of the samples. In aerated surface waters, the oxidation state of iron is the ferrous state (Fe^{2+}) which oxidizes and precipitates as ferric iron, forming a colloidal suspension of ferric hydroxide particles (CCME 1987). This orange floc was observed sporadically during the habitat survey.

The FWAL Guidelines for aluminum are based on pH, calcium and dissolved organic carbon and range from 5 to 100 µg/L. Aluminoscillicate minerals are particularly abundant in clays and are released to surface waters from soils and sediments by natural weathering and accelerated acidification processes (CCME 1987). Based on the these guidelines it appears as though the concentration of aluminum is elevated at 66% of all locations. In the Atlantic Region, surface water aluminum concentrations range from 10 to 1250µg/L (CCME 1987).

October 2002 Sampling Event

Exceedances of the CCME FWAL guidelines were registered for ammonia (one stream), aluminum (14 streams), copper (10 streams), iron (seven streams) and zinc (one stream). These results are generally consistent with the results from the June sampling event. Of note are the higher levels of nutrients in Stream Crossing No. 13 and the non-detectable levels of chromium in the surface water samples in October. Part of the upstream catchment area of Stream Crossing No. 13 is made up of an agricultural field which may have been fertilized in late summer or fall. Total suspended solids (TSS) were assessed and levels were between <2 mg/L and 6 mg/L, indicating low erosional impacts in these streams.

February 2003 Sampling Event

Stream Crossing Nos. 3, 12, 14 and 15 did not contain any water at the time of the survey as the water in their channels was completely frozen. Exceedances to the CCME FWAL guidelines were registered for ammonia (one stream), aluminum (all streams), pH (two streams), copper (all streams), iron (four streams) and lead (two streams). No exceedances were registered for nitrite, arsenic, cadmium, chromium, molybdenum, nickel, silver and zinc. Results from the February survey closely reflect results from the summer and autumn sampling events. Water colouration in the streams was remarkably clearer than it was during the previous sampling events. Total suspended solids (TSS) levels in the streams were below 10 mg/L at all but one stream crossing. Stream Crossing No. 4 registered a TSS level of 26.8 mg/L, which may be a reflection of the source of water in this stream as this crossing receives drainage water from Highway 104.

April 2003 Sampling Event

All crossings contained water at the time of the survey. Exceedances to the CCME FWAL guidelines were registered for pH (one stream), aluminum (nine streams), copper (all streams), iron (three streams) and lead (one stream). This is similar to results from the previous sampling events. While the number of aluminum exceedances were lower in April 2003 than in February 2003, levels were similar to those registered in summer of 2003. As in the February sampling event, copper levels in all streams exceeded the guidelines. While summer sampling results revealed that all but one stream had copper levels above the guidelines, only 10 streams registered copper exceedances during the autumn sampling event. The number of iron exceedances were similar to the number registered in the February sampling event and lower than the number registered in autumn and summer of 2002. The number of lead exceedances to the guideline was lower in the April sampling event compared to the summer and winter sampling event. No lead exceedance was registered in the autumn sampling event. No exceedances were registered for nitrite, arsenic, cadmium, chromium, molybdenum, nickel, selenium, silver, thallium and zinc. Total suspended solids (TSS) levels in all streams were below 5 mg/L at all but one stream crossing. Crossing # 11 registered a TSS level of 20.2 mg/L.

5.3.2.3 Fish

Presence or absence of fish species was determined, where possible, through qualitative electrofishing using a Smith-Root 12 electrofisher. This spot-check method was employed in various habitat types such as pools, riffles, and runs. Fish captured were anaesthetised using a clove oil and ethanol solution to reduce stress and injury while the fish were identified, enumerated, and measured. Electrofishing was possible in only four watercourses due to low water levels (Stream Crossing Nos. 2, 6, 8, and 11). Anecdotal information regarding the presence of fish in the streams crossed was gathered through discussions with local residents and the local DFO office by the field crew and was also used to determine the presence or absence of fish species.

Presence or absence of fish at the proposed South River crossing was determined by setting minnow traps at six locations throughout the marsh on September 29, 2000 which were collected October 5, 2000. Fish were identified, counted and measured on-site and several specimens were taken back in a cooler for identification by John Gilhen at the Nova Scotia Museum.

The marsh upstream of Stream Crossings No. 2 and 6 has been identified as important overwintering habitat for brook trout (D. Goth, pers. comm. 2002; and C. MacInnis, DFO from Taylor and Juurlink, 2004). Electrofishing in open water at the culvert yielded no specimens; poor footing and heavy vegetative cover limited electrofishing access in the marsh.

Only one individual of nine-spine stickleback and four three-spine stickleback were present at Stream Crossing No. 6 (Appendix D). Four spine stickleback and northern redbelly dace have been observed in the stream in the vicinity of the crossing (Taylor and Juurlink, 2004).

Eleven Atlantic salmon (*Salmo salar*) were caught at Stream Crossing No. 8 (West River). These fish ranged from a total length of 3.6 cm to 13.0 cm (Appendix D). Five white suckers (*Catostomus commersoni*), four banded killifish (*Fundulus diaphanus*), four northern redbelly dace (*Chrosomus eos*), three three-spine stickleback (*Gasterosteus aculeatus*), one nine-spine stickleback (*Pungitius pungitius*) and six creek chub (*Semotilus atromaculatus*) were caught in the West River. The white suckers, creek chub and banded killifish were abundant in a still-water connected to the West River. The electrofishing was confined to the RoW and the results did not show the presence of either brown or brook trout. This could possibly be explained because of the dominance Atlantic salmon parr at the RoW. Both brown and brook trout do however have strong populations in the river (D. Goth, pers. comm. 2002)

Nine-spine stickleback and three-spine stickleback were present at Stream Crossing No. 11. Only one individual of each stickleback species was caught while ten creek chub and six northern redbelly were caught (Appendix D).

Stream Crossing Nos. 1, 3, 9, 12, 13, 14 and 15 were all rated as Type 5 watercourses for salmonid habitat. Even in times of normal or high flow it is unlikely that these watercourses would be extensively used by any species of fish.

Fish species were present in Stream Crossing Nos. 6, 8, and 11. Species located by the field crew included: Atlantic salmon, white sucker, creek chub, northern redbelly dace, banded killifish, three-spine stickleback and nine-spine stickleback. Various other species are known to occur in the watercourses surveyed including: American shad, alewife, sea-run brook trout, rainbow smelt, sea-run brown trout, and American eel. These species have varying social and minor commercial value.

Six minnow traps set at the proposed South River crossing yielded between 62 and 115 mummichog *fundulus heteroclitus* and one white sucker. Large numbers of mummichogs were visible in the central island channel during trap collection.

5.3.2.4 Benthic Invertebrates

Benthic invertebrates were sampled by gently brushing invertebrates from five rocks at each sampling location. All rocks were obtained from a riffle zone upstream and downstream of the RoW. All invertebrates were preserved in a plastic sampling bag with ethanol until they could be identified.

Only Stream Crossing Nos. 5 and 8 had enough water and the proper substrate to complete the benthic invertebrate survey. Ten invertebrate families were obtained from the crossings (Appendix D). Crossing No. 8 contained more families of invertebrates than Crossing No. 5. Overall most of the species had low (*Odontoceridae*) to medium (*Chironomidae*) tolerance level to organic pollution (Mandaville 2002) (Appendix D).

The collection of benthic samples for the proposed South River crossing was achieved by collecting the samples using a stainless Ponar (grab) sampler from a canoe at seven sampling stations. Samples were transferred to plastic ziplock bags and sent for identification. Eleven invertebrate taxa were obtained from the samples taken at the crossing (refer to Appendix E).

5.3.3 Residual Environmental Effects Evaluation Criteria

The definition for significant environmental effects on fish is population-based and takes into account natural variation and potential for population recovery.

A **significant** adverse environmental effect is one that significantly alters a fish population or a portion of it to cause a decline or change in abundance or distribution of the population over one or more generations. Natural recruitment (reproduction and immigration from unaffected areas) may not re-establish the population to its original level. A significant population effect on fish habitat may alter the valued habitat physically, chemically, and/or biologically in quality or extent, such that there is a decline in the species diversity of the habitat. This effect may be reflected by a decline in abundance and/or change of habitat components (*i.e.*, sediment quality, food resources, water quality, and riparian vegetation).

A **positive** effect is one which may enhance the quality of habitat, increase species diversity, or increase the area of the valued habitat. A positive effect may enhance a population such that an increase in that population is evident.

5.3.4 Potential Issues, Interactions and Concerns

During construction, operation and maintenance, potential interactions with fish and fish habitat may be attributed to the following activities:

- clearing and grubbing of riparian vegetation;
- blasting, ripping, infilling and grading;
- watercourse crossing;
- asphalt repair, repainting or shoulder regrading; and
- salt application, and snow removal.

The potential effects of these activities include erosion and sedimentation, fish mortality, stream morphology alteration and degradation, acid drainage and water quality change. Potential effects and mitigation associated with malfunctions and accidental events are discussed in Section 7.

Erosion and Sedimentation

The introduction of sediment to a lotic (moving water) system by way of erosion, sedimentation or instream work, is the main area of concern during the construction phase. The highest risk for erosion and sedimentation will occur during clearing and grubbing, topsoil stripping and grading, and watercourse crossing and backfilling.

Erosion and sedimentation can occur anywhere soil is exposed. Potential characteristics of the proposed stream crossing sites that may increase the risk of erosion and sedimentation include stream morphology, high discharge, and the presence of erodible soils. Soil analysis revealed moderate to highly erodible loam soils at the proposed stream crossing sites.

The area of the proposed highway route shows some evidence of past logging. Both clear-cuts and selective harvest logging operations were evident while conducting the stream assessments. Siltation and erosion were observed where heavy logging had occurred. Stream Crossing No. 10 was devoid of stabilizing riparian vegetation because of recent logging activities and showed signs of erosion in sensitive meander areas. Furthermore the whole channel was blocked off by cuttings from the forestry operation. Despite low discharge many streams showed evidence of siltation; it is assumed that during bankfull stage some streams would have high erosion potential. Residential impact was minimal, with sparse population and development along the proposed route.

Increased sediment loads may have harmful effects on fish and fish habitat. Suspended sediment in the water column may cause direct physical damage to fish by abrading gill membranes and skin, and causing susceptibility to secondary infection. Feeding habits can also be impaired, particularly in salmonids and trout which are visual feeders, invertebrate populations may also be adversely affected. Once deposited, silt clogs gravelled areas that are potential spawning habitat, increasing egg mortality and destroying habitat for small fish and invertebrates.

In the case of small, meandering streams, heavy sedimentation can block flow, preventing fish migration and causing adverse morphological change. Brook trout prefer streams with a relatively high percentage of pools, and sedimentation and erosion can adversely impact these important habitats.

Infilling of wetlands associated with streams (*e.g.*, Brierly Brook) is not expected to have a significant effect on fish and fish habitat since the portions of wetlands to be infilled contribute a minor proportion of water discharge compared to the entire wetland complexes and catchment areas of each watercourse. Therefore the nutrient loading will not significantly change and overwintering fish habitat, if present, would not be altered, assuming adequate fish passage is provided.

Blasting

Sections of the proposed alignment that pass through bedrock areas may require blasting if the rock is not rippable. Blasting in and adjacent to watercourses may cause direct deleterious effects upon fish health from blast percussion, excessive dust deposited in streams, disturbance to the habitat, and introduction of acidic drainage if the bedrock contains sulphide mineralization.

Clearing

The removal of stream-side vegetation during construction of the highway has potential for moderate impacts as shading from the canopy maintains consistent and lower water temperatures more suitable for fish species. Increased algal and macrophyte growth may also choke small streams or lower dissolved oxygen levels through decomposition. Salmonids are highly sensitive when exposed to high summer temperatures generated from exposed water. The potential for death, susceptibility to opportunistic pathogens, and lowered overall reproductive potential is increased. Clearing activities in the vicinity of a watercourse will cause disturbance to the protective vegetative buffer adjacent to the watercourse and could subsequently lead to erosion of the approach slopes and sedimentation into and the obstruction of the watercourse. Riparian diversity supports diverse invertebrate habitat and is a component of many aquatic invertebrates' life cycles. Clearing of riparian vegetation lowers the availability of prey sources for salmonids and other insectivorous fish species.

Culvert Installation

Watercourse beds and banks may be disturbed during the installation of culverts. Fish movement could be impaired or fish may be displaced during culvert installation, and following installation if the culvert is not properly placed or measured (*i.e.* sufficient depth and flow). Instream work also contributes to sedimentation and the potential for damaging stream habitat. If altered, the stream must be remediated to natural conditions. Flow alterations must be kept short and be completely reversible.

Excavation in Acid Generating Bedrock

Although acid generating bedrock is not anticipated within the study area, it is noted that excavation in areas with acid generating potential poses risks to the aquatic environment. Runoff from exposed sources of sulphide mineralization can drastically reduce water quality by acidification. Acidic waters liberate heavy metals which can reach toxic levels for fish and other aquatic life. Aquatic macroinvertebrates, fish eggs, and fry are most susceptible to acidic drainage. Some of the pHs in watercourses assessed (stream crossings 1, 2 and 15) were slightly depressed making them susceptible to acidification from external sources.

Operation and Maintenance Activities

Repetitive clearing of overhead cover along the RoW at watercourse crossings may affect stream temperature control following construction. Road salting could lead to degradation of water quality and fish habitat downstream of the proposed highway by increasing the salt concentration and potentially inducing osmotic stress to fish. Shoulder grading could result in gravel being washed into nearby watercourses.

5.3.5 Analysis, Mitigation and Residual Environmental Effects Prediction

DFO has developed the Policy for the Management of Fish Habitat (1986), which applies to all projects and activities, in or near water, that could alter, disrupt, or destroy fish habitats by chemical, physical, or biological means. The guiding principle of this policy is to achieve no net loss of the productive capacity of fish habitats. The Policy for the Management of Fish Habitat is regulated by the following sections of the *Fisheries Act*: Section 20, 21, 22, 30, 32, 35, 37, 40 and 43, which are administered by DFO. Under the terms of a Memorandum of Understanding with Environment Canada, the Minister of Fisheries and Oceans is legally responsible for all sections of the *Act*. However, for Sections 36 to 42, Environment Canada administers those aspects dealing with the control of pollutants affecting fish. DFO co-operates with Environment Canada in the establishment of federal priorities for the protection of fish and their habitats from deleterious substances.

With respect to culvert installations and extensions, DFO (*Fisheries Act* Section 20) requires safe fish passage in all watercourses that bear fish. This is administered in close collaboration with NSDEL through the Water Approval process (formerly Watercourse Alteration Permit) under the provincial *Designated Activities Regulation*. This application process applies to new culvert installations and existing culverts which may require extensions and upgrading. DFO encourages all owners or occupiers to inspect existing culverts and upgrade these fishways, if necessary, to ensure adequate fish passage. Upgrades and new culvert installations will be completed as per the criteria presented in Conrad and Jansen (1994), or latest applicable DFO guidelines.

5.3.5.1 Construction

Scheduling

Construction undertaken in or near a watercourse, particularly work involving heavy machinery, may have adverse effects on fish resources. Prudent timing of such instream works can reduce adverse effects. Salmonid species deposit eggs in the substrate of a watercourse in the autumn. The eggs incubate throughout the winter in the substrate, and emerge to feed on external food source in the spring. Spawning, egg incubation and hatching occur very rapidly in the spring and early summer. Table 5.13 provides important biological information on key species.

Table 5.13 Spawning and Emergence Times for Key Fish Species

Species	Spawning Dates	Emergence Dates
Brook trout	Late September and November	early to mid-April
Brown trout	October and November	early to mid-May
Atlantic salmon	October and November	mid-May to early June

Where fish are present and construction schedules permit, construction of watercourse crossings will be scheduled for periods when there will be less disturbance to fish populations (*i.e.*, June 1 through September 30). If there is a requirement to conduct construction activities outside the preferred window, compensation and/or additional mitigative measures will be implemented as required. The following periods and areas will be avoided where practical: spawning and incubation periods, critical overwintering areas during winter periods, and migration routes where construction may obstruct fish movements. For spring-spawning species, the period of least sensitivities is generally from mid-July to late September. Fall-spawning species are generally least sensitive between June and mid-September.

Erosion and Sedimentation

Maintaining optimal flow, habitat and fish passage is important for watercourses which naturally have lower flow and discharge potential. The potential of losing smaller watercourses exists if flow is altered or sedimentation increased. These potential passageways for fish species are of prime importance in maintaining healthy and diverse fish populations. Although many of the streams assessed did not contain fish or optimal fish habitat, degraded water quality or siltation in these tributaries could have potential damaging effects to fish and fish habitat downstream of the crossing, and must therefore be protected from Project sedimentation.

Some degree of erosion and sedimentation into watercourses can be expected from equipment activity and earth moving on the RoW, soil erosion on approaches and banks, and substrate disturbance at watercourse crossings. These temporary effects can be minimized by appropriate erosion and sedimentation prevention and control measures which will be specified in an EPP for the Project. All personnel will comply with environmental protection procedures established in the EPP, including a Work Progression Schedule. The Work Progression Schedule is a clause designed to ensure construction in any work area is carried out continuously from initiation to completion to ensure orderly progression of the work and to minimize exposed soil on construction sites. Once a site has been grubbed, it must be graded, seeded and have final slope protection in place within 30 calendar days (NSTPW 1997 and revisions). Erosion and sediment control practices will be outlined in the EPP.

General mitigative measures at watercourse crossings for clearing, grubbing, backfilling, blasting will be detailed in the EPP. No instream work will commence until all erosion and sediment control measures are implemented. There are three categories of erosion and sediment control for construction projects: runoff controls, erosion protection, and sediment interception.

Runoff controls limit or contain soil movement from the construction site. Minimizing raindrop impact on the soil, reducing runoff volume, and decreasing runoff velocity are three of its main objectives. Generic controls considered for this Project include the following.

- To reduce the velocity of runoff, crop residues, plants and rough soil surfaces help spread the flow of water over a greater area and into a thin layer.
- Diversion berms are commonly used on slopes to intercept sheet flow on exposed surfaces and to reroute flow into undisturbed areas. Erosion protection is required at the berm outlets.
- Flow checks are a temporary measure constructed in ditches, swales, or chutes to reduce hydraulic gradient and flow velocity, thus minimizing the potential for erosion of the channel.

Erosion protection measures are used to reduce or eliminate the detachment of soil particles by falling rain or droplets, or to resist sheet [illegible] annel flow. These measures are placed on, or applied to, the soil surface and are often used in conjunction with runoff control and sediment interception measures. Revegetation is generally used only for permanent protection and often requires another form of temporary protection measure to be successfully implemented.

Soil loss from slopes may occur even with erosion and runoff control measures. If this soil can enter a waterbody, mitigative measures will be required to intercept it. Methods used to trap sediment include vegetated buffer strips, silt fences, filter berms, and sediment traps.

Thorough maintenance of all temporary and permanent erosion and sediment control measures will ensure the integrity of the aquatic resources they protect. Monitoring of the site following major rainstorms will ensure that runoff control devices are effective and accumulated sediment is removed.

Where reasonable, a 75 m buffer zone will be established to exclude grubbing and grading near watercourses adjacent to watercourse crossings until culverts are installed. Substrate composition will be recorded at crossing areas prior to cut operations to confirm substrate in the precise area of the surveyed RoW. Substrate disturbed or removed during construction will be replaced with the same or a better grade of material to minimize impacts to spawning or rearing habitats, where appropriate.

The risks of sedimentation will be minimized by strict adherence to the EPP, Environmental Construction Plans and by the presence of at least one on-site contractor who has received training in erosion and sediment control. The duration of work at each stream crossing will be short, any instream disturbance will be temporary, and the frequency of disturbance will be low (*i.e.*, one time only).

Blasting

Should blasting be required during construction in or near a watercourse, a permit will be required from DFO for the use of explosives (Section 28 of the *Fisheries Act*). Blasting will be conducted in accordance with "Guidelines for use of Explosives in Canadian Fisheries Waters" (Wright and Hopky 1998). Effects from blasting to fish and fish habitat will be minimized through the following mitigative measures:

- exclusion of fish from the blasting area, where practical, using appropriate methods;
- use of non-propagating explosives;
- use of time delay blasting caps for detonation of multiple charges;
- over-drilling of holes to detonate each charge; and
- use of decked charges.

Construction (including blasting) in or near watercourses will be undertaken between June 1 and September 30, outside of the biologically sensitive period to avoid the sensitive and critical fish life stages. Explosive use, if necessary, will be infrequent and limited to only a few areas, if any, along the RoW.

Clearing

Riparian vegetation will be cleared for the highway alignment. Vegetation will be allowed to grow along the bank of the watercourse to maintain the stability of the banks. Where vegetation must be removed for culvert installation, it will be removed as late as possible and the affected area will be re-vegetated as soon as possible. Vegetation will also provide adequate shade to prevent an excessive rise in water temperature, reduce overgrowth of small streams by invasive gramminoid plant species (e.g., grasses, sedges, bulrush) and prevent prolific algal growth. NSTPW will avoid long skids of timber on steep slopes adjacent to watercourses as well as falling or skidding trees across a watercourse. Where technically possible, NSTPW will not use heavy machinery within 10 m of streambanks. Any trees needed to be cut within 10 m of the watercourses will be cut by hand or by machinery able to 'reach in' within those areas. Residual effects are expected to be temporary and non-significant, as the geographical extent is limited, the duration of construction is short and the removal of vegetation is reversible through natural succession and replanting of appropriate native vegetation.

Culvert Installation and Extension

Instream work will be undertaken between June 1 and September 30 to avoid sensitive and critical fish life stages. All watercourse crossings will be properly sized and designed to ensure watercourse flow and, in fish-bearing streams, to allow fish passage as per the criteria detailed in Conrad and Jansen (1994), or the latest applicable DFO guidelines). All culvert designs requiring fish passage will be reviewed by DFO under

Section 20 of the *Fisheries Act*. NSTPW will work with NSDEL and DFO to ensure that new culverts installed in fish-bearing streams will: not obstruct fish passage; handle peak flows; maintain natural stream conditions (width, habitat); and that culvert extensions will also adhere to these same criteria. Culvert extensions or upgrades may be required where the alignment meets existing routes.

The hydrotechnical evaluation conducted for this Project (Appendix B) recommended that a free-spanning structure be considered at the RoW on West River and that a spanning structure (open bottom culvert, bridge) be installed at Stream Crossing No. 11 (8+150), the unnamed tributary to West River. The South River Impact Study recommended that a four span steel girder bridge be constructed at the proposed South River crossing.

Erosion and sediment control structures, as described above will be used during the installation. Culvert installation plans containing other installation details will be developed prior to construction and will be implemented during construction activities.

Excavation in Acid Generating Bedrock

As discussed in Section 2.4.12, acid producing bedrock is not anticipated to be encountered during Project construction. Geotechnical drilling conducted prior to construction will provide opportunity to test for acid producing potential.

In the unlikely event that acid generating bedrock is encountered during construction and is unavoidable (refer to Section 2.4.12 for avoidance measures during design phase), the following mitigation measures will minimize potential effects:

- Evaluation of depth to bedrock by geotechnical investigation and testing for acid producing and acid consuming potential will be undertaken prior to any excavation in bedrock at, and in the vicinity of, watercourse crossings where there is concern for site runoff into nearby watercourses. Testing will comply with specifications outlined in the *Sulphide Bearing Material Disposal Regulations* under the Nova Scotia *Environment Act*.
- Surface water quality data will be collected for baseline assessment of pH, metals, acidity, alkalinity, sulphate, and conductivity before any construction commences.
- Exposure of acid generating bedrock to rain and air will be reduced by keeping any exposed or stockpiled material covered, and capturing and neutralizing any runoff before discharge. The Project Engineer will ensure erosion control measures are properly installed and maintained.
- If excavated material exceeds acid generating limits, bedrock will be disposed of in accordance with the *Sulphide Bearing Material Disposal Regulations*.
- Exposed bedrock will be backfilled with clay or other low permeability material.

- The duration of construction in areas prone to acid generation will be minimized and surface water pH, acidity, alkalinity, sulphate, and metals will be monitored post-construction upstream and downstream of the crossing site.

If surface water quality monitoring (post construction) shows lowered water pH, the site will be reassessed and mitigation modified to correct the acidic release. NSTPW will develop appropriate mitigative measures in consultation with environmental agencies.

Summary

Primary concerns during construction are the potential degradation of fish habitat and stream morphology due to sedimentation and erosion. More immediate, direct effects on fish populations could result from the excavation of acid generating bedrock or from blasting in proximity to watercourses. Retention of vegetation along the banks of watercourses is important to prevent a rise in water temperature, while consideration of construction schedules promotes minimal disturbance of fish during critical periods.

Because of the small flow potential, narrow stream width and meandering character of many of the streams assessed, it is probable that more than one morphological feature will be compromised within the RoW. Pools, which are important brook trout habitat, will be channelized at some proposed watercourse crossings. Where feasible, location of watercourse crossings in areas of more consistent gradient and naturally straighter stream character, are highly recommended, as this will significantly decrease adverse impacts to fish and fish habitat.

Provided the proposed mitigative measures are applied, no significant adverse environmental effects on fish and fish habitat are anticipated during construction.

5.3.5.2 Operation and Maintenance

Mechanical clearing will primarily be used for vegetation control during highway operation on the RoW (*e.g.*, road shoulders and interchanges). There will be no herbicide applications under any of the following legislated conditions:

- within a 30 m buffer zone of any watercourse;
- within any distance of any watercourse prescribed on a product label; and
- within 60 m of a protected water supply.

Permanent erosion control measures will mitigate long-term effects of erosion and sedimentation. Appropriate erosion control measures for each watercourse bank will be specified in site specific environmental control plans developed as part of the highway design. These will minimize the potential for stream bank destabilisation and erosion. Residual environmental effects are expected to be non-significant, assuming that minimal to no disturbance of slopes will occur post-construction and that the effects are reversible.

Highway maintenance is typically of short duration and affects short distances or small sections of highway. However, a comparison of the volume of runoff from the proposed highway to the flows in the receiving watercourses indicates potential impact of runoff containing contaminants on the water quality of the local surface water resources (Appendix B - Hydrotechnical Evaluation).

An extensive field monitoring and laboratory analysis program conducted in the United States indicated no significant impact to receiving water ecology resulted from operation of highway facilities with low to medium average daily traffic (ADT <30,000) (Lord 1985). Results from adult toxicity bioassays of undiluted highway runoff concluded that:

- the quality of the receiving water may be temporarily degraded by runoff from a storm event, but will rapidly return to its previous state;
- detrimental substances in the runoff water are flushed out of the receiving waters and do not linger; and
- detrimental effects on the biota of the receiving water would be from direct toxicity, not indirect or delayed effects of assaults on other components of the system.

Experience within Nova Scotia has demonstrated a large degree of dilution of road salt runoff, resulting in occasional degradation of water quality immediately adjacent to the salted alignment, decreasing in concentration with distance downstream from the source (Gibb and Jones 1974).

Environment Canada's Code of Practice for the Environmental Management of Road Salts (Annex A: Environmental Impact Indicators for Road Salts) (Environment Canada 2004) presents thresholds associated with concentrations for chloride in surface water and impacts on aquatic biota. These values are summarized in Table 2 of the Salt Management Strategy (Appendix L). Concentrations of chloride of approximately 140 mg/L should be protective of freshwater organisms for short-term exposure. This value is based on a 4-day LC_{50} for *Ceriodaphnia dubia* (water flea). Environment Canada's Code of Practice also references the United States Environmental Protection Agency who has developed a similar guideline. This guideline indicates that biota, on average, should not be negatively if the one-hour average concentration of chloride does not exceed more than 860 mg/L more than once every three years and/or the four-day average concentration of chloride does not exceed 230 mg/L more than once every three years (Environment Canada 2004).

Concentrations of water samples taken along the existing Highway 104 alignment in the Antigonish area indicate elevated chloride and sodium levels with some chloride levels up to 100 mg/L at some of the smaller stream crossings.

Section 2.5 and Appendix L detail measures undertaken by NSTPW to minimize effects of road salt use on the environment. Given the current operating standards and the unlikelihood of adverse residual environmental effects on fish, no additional mitigative measures are proposed with respect to road salt application.

Highway maintenance is typically of short duration and involves short distances or small sections of highway. Furthermore, due to the small volume of runoff from the proposed highway compared to the flows in the receiving watercourses, the potential impact of runoff containing contaminants on the water quality of the local surface water resources is not likely to be significant.

In summary, provided the noted mitigative measures are implemented, no significant residual adverse environmental effects on fish and fish habitat during highway operations are anticipated.

5.3.6 Follow-Up and Monitoring

All construction activities will require inspection and monitoring to ensure that erosion and control structures are appropriately installed, maintained and removed. Surface water quality monitoring for total suspended solids and acid rock drainage may be required during construction in accordance with federal and provincial regulations. Follow-up inspections will be necessary to evaluate site and habitat restoration, bank protection and stability, and to ensure culvert installation allows fish passage where required. Additional follow-up and monitoring will be determined in consultation with federal and provincial regulators.

5.3.7 Summary of Residual Environmental Effects Assessment

Provided the proposed mitigative measures are implemented, no significant residual adverse effects on fish and fish habitat are anticipated during highway construction or operation. Tables 5.14 and 5.15 summarise the residual environmental effects evaluation for fish and fish habitat.

Table 5.14 Residual Environmental Effects Assessment Matrix
Fish and Fish Habitat (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing and grubbing of RoW	• Erosion and sedimentation (A) • Alteration of riparian habitat (A)	• Erosion and sediment control • Monitoring (suspended solids) • Adherence to the EPP • Establish 75 m buffer zone to exclude grubbing and grading until crossing structures are installed	1	4	2 / 1	R	2	N	3
Excavation, infilling, and topsoil stripping and grading	• Erosion and sedimentation (A) • Acidic drainage (A)	• Erosion and sediment control • Acid drainage risk testing during geotechnical program; application of management program if necessary • Adherence to the EPP • Monitoring (suspended solids; acid drainage parameters if necessary)	1	4	2 / 1	R	2	N	3
Blasting	• Blast percussion (A) • Erosion and sedimentation (A) • Habitat disruption (A) • Acidic drainage (A)	• Exclusion of fish from area • Erosion and sediment control • Acidic drainage management if necessary • Adherence to DFO guidelines for blasting near watercourses (Wright and Hopky 1998) • Adherence to the EPP • Monitoring (suspended solids, pH, etc.) • Schedule instream work between June 1 and Sept. 30 • Habitat compensation for HADD	1	3	2 / 1	R	2	N	3

Table 5.14 Residual Environmental Effects Assessment Matrix
Fish and Fish Habitat (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Watercourse crossing and culvert installation	• Erosion and sedimentation (A) • Blasting (A) • Habitat disruption (A) • Displacement of fish (A)	• Erosion and sediment control • Adherence to the EPP • Monitoring (suspended solids) • Adherence to DFO guidelines for blasting near watercourses (Wright and Hopky 1998) • Habitat restoration • Appropriate crossing method to minimize flow disruption • Culvert designs requiring fish passage to be reviewed by DFO • Culvert alignment and sizing to accommodate fish passage as per DFO Guidelines • Schedule instream activities between June 1 and Sept. 30	1	4	2 / 1	R	2	N	3

KEY

Magnitude: 1 = Low: i.e., specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: i.e,, portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: i.e., affecting a whole stock, population or habitat, outside the range of natural variation

Geographic Extent: 1 = <500 m^2; 2 = 500 m^2 -1 km^2; 3 = 1-10 km^2; 4 = 11-100 km^2; 5 = 101-1000 km^2; 6 = >1000 km^2

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects

Residual Environmental Effect Rating: S = Significant adverse environmental effect; N = Non-significant adverse environmental effect; P = Positive environmental effect

Confidence: 1 = Low level of confidence; 2 = Medium level of confidence; 3 = High level of confidence

Table 5.15 Residual Environmental Effects Assessment Matrix Fish and Fish Habitat (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Vegetation control	• Chemical pollution of watercourse (A) • Erosion and sedimentation (A) • Alteration of riparian habitat (A)	• No application of herbicides: 1) within 30 m of any watercourse; 2) prescribed on product label; and 3) within 60 m of a protected water supply. • Installation of permanent erosion and sediment control measures • Adherence to sediment and erosion control measures and vegetation management plans detailed in the EPP • Maintenance of a vegetated buffer zone around watercourses	1	1	5 / 1	R	2	N	3
Road De-icing	• Runoff of salt into watercourses; osmotic stress of fish (A)	• Wet salt prior to application to reduce amount required • Implement Salt Management Strategy	1	1	2 / 2	R	2	N	2

Refer to Table 5.14 for Key.

5.4 Rare Herpetiles

Rare herpetiles (reptile and amphibian species) are considered a VEC due to concerns with protecting species biodiversity. Rare species, by definition, are of interest and often warrant special consideration. This VEC includes all reptile and amphibian species considered to be rare in Canada (COSEWIC 2004) and Nova Scotia (ACCDC 2002a; NSDNR 2002a) that may interact with this project. Also included are herpetile species not considered to be rare which may be sensitive to development due to habitat disturbance from anthropogenic activities.

5.4.1 Boundaries

The spatial boundaries for assessment of rare herpetiles includes habitats with a relatively high likelihood of supporting these species, such as wetlands of all types, forest habitats adjacent to wetlands, and intervale habitats of rivers and streams, contained within the study area (Figure 5.4).

Though capable of undertaking short seasonal movements to and from suitable breeding and hibernating sites, the terrestrial and freshwater herpetiles of Nova Scotia are generally non-migratory. Resident species will remain in the study area year round except in cases where some key habitat component occurs outside the study area. Within the study area, certain species (*e.g.*, spring peeper) may be present in specific habitats (*e.g.*, breeding pools) only at certain times of the year. During the late fall to winter period resident reptiles and amphibians will be in hibernation. Temporal boundaries consider the potential for herpetiles to be affected by Project construction within their active season, and by operation throughout the duration of Project activities.

5.4.2 Description of Existing Conditions

Information regarding herpetiles in the study area was obtained from existing information sources (*e.g.*, ACCDC 2002a, Gilhen 1984; Gilhen and Scott 1981; and Scott 1994) and field surveys. Information collected for the South River Impact Study was gained through discussions with John Gilhen. The findings of the study (Appendix E) concur with the findings of the field program and investigations conducted in the summer of 2002. Herpetile surveys were conducted along the proposed RoW concurrent with the breeding bird survey on June 18-19, 2002 and the rare plant and wetland survey August 20-23, 2002. Almost all of the terrestrial habitat found along the proposed route provides habitat for reptile and amphibian species. These habitats include coniferous, deciduous and mixed wood forests of various ages, clear-cuts, abandoned pasture, and edges of residential and commercial areas. Various wetland habitats suitable to host breeding adult, resident adult, transitory adult, and larval amphibians, as well as certain reptiles, are found within the study area. These include a variety of wetland types, as well as the riparian vegetation zones around rivers, streams, roadside ditches and pools, and wheel rut pools in wetlands and disused woods roads.

Nova Scotia has five species of snakes and four species of freshwater turtles in its reptilian fauna. Three species of snake were recorded during the surveys including: the maritime garter snake (*Thamnophis sirtalis pallidula*), the northern redbelly snake (*Storeria o. occipitomaculata*) and the eastern smooth green snake (*Lilochlorophis vernalis*). These species are considered common to the province. While generally suitable habitat for the northern ringneck snake(*Diadophis punctatus edwardsi*) is present along the proposed route, no specimens were encountered. Records of this otherwise provincially common species are lacking in the area (Gilhen 1984). The study area is far from the disjunct range of the northern ribbon snake(*Thamnophis sauritus septentrionalis*), the sole snake species of provincial concern (ranked as S2S3 (ACCDC2002a)) which, in Nova Scotia, is confined to the warm southwestern interior. No records exist for this species in Antigonish or its neighbouring counties (Gilhen 1984) and none were encountered during the survey.

Of the turtle species common to Nova Scotia, one species, the common snapping turtle (*Chelydra serpentina*) was recorded during the field surveys. A juvenile common snapping turtle was noted in an oxbow pool along the West River just down stream from the RoW. Snapping turtles would be expected to perennially occupy most of the larger bodies of fresh water in the area as well as some of the smaller ones adjacent to rivers and ponds on a seasonal basis.

While aquatic habitat with the capacity to support populations of the eastern painted turtle (*Chrysemys picta picta*) was present in certain beaver flood ponds on streams and ox-bow pools near and within the RoW crossing of the West River, none were encountered along the proposed corridor. Eastern painted turtles are timid and are quick to disappear from basking spots into the water, making detection difficult. Furthermore, there are few records of eastern painted turtles in the more northern regions of the mainland (Gilhen 1984) and as such there may not be populations within the Project area.

Two freshwater chelonian species are of concern in Nova Scotia; namely the provincially endangered Blanding's turtle (*Emydoidea blandingi*) and the vulnerable wood turtle (*Glyptemys insculpta*) (NSDNR 2002b). The Blanding's turtles are excluded from the potential turtle fauna of the Project area, as, like the northern ribbon snake, their disjunct population in Nova Scotia is centred in the warmer south-west interior of the province. No records of any populations of this species are known from Antigonish County or any neighbouring county.

The wood turtle is known from the general area, (ACCDC 2002a) particularly associated with the West and South Rivers, and one of the surveyors had previously encountered the species upstream of the West River crossing. Wood turtles are a species of concern nationally and provincially. They are ranked as S3 by the ACCDC (2002a). The S3 rank indicates that these turtles are uncommon throughout their provincial range, or only found in a restricted range, even if abundant at some locations. Provincially, they are ranked as yellow, or sensitive (NSDNR 2002a), as well as vulnerable under the new *Endangered Species Act* of Nova Scotia (NSDNR 2002b).

No wood turtles were encountered during survey periods, however wood turtles are generally widely dispersed and cryptic and are not easily detected. The June survey period coincided with local nesting activity for this species. No attractive nesting sites were encountered along the route that would contain seasonally concentrated nesting females.

Wood turtle populations are almost invariably associated with streams, creeks, and rivers and the associated rich intervale forest, shrub communities, as well as with the meadows and farmland terrestrial habitat associated with these watercourses. Streams with sand, or sand and gravel bottoms are preferred by these turtles but rocky streams are also acceptable. Wood turtles may wander some distance from water during summer foraging but characteristically remain within linear home ranges. These home ranges are 1 to 6 ha in size and are centred on a suitable river or stream where unvegetated or sparsely vegetated sandy beaches and banks serve as nesting sites. Traditional natural nesting sites consist of sandy river beaches but may also include select anthropogenic sites such as railway grades and roadsides. Wood turtles traverse their ranges all summer long, and are in and out of the water during this period. Some turtles may travel considerable distances up small tributaries that lack suitable nesting sites and hibernacula, but which offer good foraging opportunities. These smaller streams may serve as dispersal corridors between populations on different river systems.

Rich intervale and cobble bottom river habitat suitable for wood turtles was present at the West River crossing site. The summer terrestrial foraging habitat was excellent and a quiet side pool system near the RoW would provide good aquatic foraging and cover habitat for juvenile wood turtles. The river at this location is fast flowing and shallow and does not provide core river hibernacula sites. Similarly, no prime nesting sites were found near the river at this location.

The South River also hosts wood turtles however, the RoW crossing point is downstream of the existing Highway 104 in an estuarine transition area of the river which does not constitute favourable wood turtle habitat. The third site with good potential to provide habitat for wood turtles is Stream Crossing No. 11 (8+150) (Figure 5.4). At this site, a recent beaver dam impounded a section of the watercourse, resulting in a silty bottomed pond. Sections of the stream, both upstream and downstream from this area, were suitable as wood turtle dispersal and foraging corridors. No core habitat features such as breeding sites or hibernaculae occurred at this site.

Nova Scotia has eight species of frogs and toads and five species of salamander. Seven species of frogs and toads were recorded in the study area including northern spring peepers (*Pseudacris c. crucifer*), northern leopard frogs (*Rana pipiens*) pickerel frogs (*Rana palustris*), wood frogs (*Rana sylvatica*), green frogs (*Rana clamitans melanota*), mink frogs (*Rana septentrionalis*), and American toads (*Bufo a. americanus*). Spring peepers and wood frogs were associated with the majority of small wetlands and other habitats offering ephemeral pool habitat in association with woodland along the route. Green frogs were generally distributed wherever significant small pool habitat or other larger bodies of fresh water were present. Mink frogs, along with green frogs and leopard frogs, were recorded from still water pool habitats near the West River crossing site and from a beaver impounded stream at 8 +150. Pickerel frogs were found only at the beaver impounded stream. American toad tadpoles were noted from a number of pool sites while adults and juveniles were encountered at various points along the proposed bypass routing. The frog and toad species recorded in the area are considered common in Nova Scotia.

There are five salamanders known to inhabit Nova Scotia; the yellow-spotted salamander, the eastern redback salamander, the red-spotted newt, the blue-spotted salamander and the four-toed salamander. Of these, two were encountered during the survey, two would be expected to occur within the study area, and one, the four-toed salamander, is not known from the area (J. Gilhen, pers. comm. 2002). The two common species recorded during the filed survey were the yellow-spotted salamander (*Ambystoma maculatum*) and eastern redback salamander (*Plethodon cinereus*). Evidence of egg masses and larval yellow spotted salamanders, were noted from several woodland pools, ditch pools and wetlands along the route. Leadback and redback phases of the eastern redback salamander were noted from various woodland types during the survey. The rare erythristic phase of the eastern red back salamander was not and is not expected to be found within the study area as the RoW did not pass through the higher altitude, sugar maple (*Acer saccharum*) dominated hardwood forest habitat that typically host this variant (Gilhen 1984).

Two relatively common salamander species, not encountered but which would be expected to occur along the proposed route include the red-spotted newt (*Notopthalmus v. viridescens*) and the blue-spotted salamander (*Ambystoma laterale*). While adult newts can occur in rather dense populations in certain water bodies, they are often much more diffuse in a given habitat and not always readily detectable. The deeper pools, beaver ponds, river oxbow pools and adjacent woodlands present in the study area would provide suitable habitat for this species.

Blue-spotted salamander adults are not reliably detectable outside the spring breeding season. Unlike yellow-spotted salamanders, the eggs of these species are not laid in conspicuous masses and as such are much more difficult to detect, post breeding. The blue-spotted salamander larvae are not always readily separable from the yellow spotted salamander larvae. In the past, blue-spotted salamanders have been seen locally by one of the survey biologists at Brown's Mountain and near the South River. During the survey they were reported by a local farmer at the West River crossing area. Blue-spotted salamanders, though widespread in Nova Scotia, appear to be the most geographically restricted salamander species. They are found in areas of sedimentary rock of a more circumneutral nature than the acidic substrates that overlie much of the province. These salamanders would be expected to breed in suitable ephemeral pool habitat throughout the area.

5.4.3 Residual Environmental Effects Evaluation Criteria

A significant adverse environmental effect occurs when the population of a species is sufficiently affected to cause a decline in abundance and/or change in distribution beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return the population to its former level within several generations.

A positive effect occurs when Project activities help to increase populations and/or diversity of species.

5.4.4 Potential Issues, Interactions and Concerns

Road building can adversely affect herpetile populations by: fragmenting habitat; removing or adversely modifying core habitat features such as breeding sites and hibernaculae; acting as barriers or gauntlets to population dispersal and local movements; and through the introduction of additional sources of mortality. Wood turtles are long-lived species and do not mature sexually until the age of 14 - 20 years or more. As such, it is essential to maintain high survivorship of breeding adults and moderate recruitment for population persistence. Highways can adversely affect wood turtles through direct mortality (*i.e.*, vehicle strikes), by removal of turtles from the area and other factors that promote additional mortality.

Positive effects of road building for herpetile species in general include the possible formation of road side ditch pool habitats which may be very productive for certain amphibian species, as well as the creation of sunlit edge habitats along woodlands, providing habitat that favours certain snake and other herpetile species. For many turtle species, any potential positive effects of road building and operation are generally outweighed by adverse effects.

5.4.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.4.5.1 Construction

Should it be determined through a pre-construction survey program that wood turtles are present within the study area, certain preemptive measures will be required to promote protection of this species at specific sites during highway construction. The proposed RoW passes two sites considered to have a high likelihood of supporting populations of wood turtles. A stream and riparian corridor near Stream Crossing No. 11 (8+150) provides potential wood turtle habitat, but the primary site is at the West River crossing. No significant nesting sites were apparent at the West River crossing or the stream near Stream Crossing No. 11, therefore, there would be no need to avoid construction on the shores of these sites during the June nesting season or the June to September incubation season.

Prior to clearing and grubbing of riparian areas within 100 m of these two sites during the period from mid April to early October, a herpetologist and searchers will be dispatched to the area of construction to identify terrestrially foraging wood turtles at risk from construction activities. These turtles will be relocated outside of the RoW but within the stream habitat corridor in which they were found.

Subsequent to the initial search and relocation of the turtles by the herpetologist, construction crews will be briefed in the identification of and relocation procedures for wood turtles. Construction activity during the period from May to October will require work crews to check for wood turtles in the way of such activity. If wood turtles are found in the construction area they will be picked up and moved just off site, along the same habitat corridor in the direction of travel the turtle was originally oriented. A New York State study (Carroll and Ehrenfeld 1978) showed that 84 % of wood turtles displaced less than 2 km overland were able to return to their home range. Moving of wood turtles 100 m or so from the original site where they were found should not unduly disrupt the turtle. These procedures will be included in the Project EPP.

Provided the proposed mitigative measures are implemented, no significant adverse effects on wood turtles or other herpetile species are anticipated during construction.

5.4.5.2 Operation and Maintenance

Operation of the highway can adversely affect wood turtle populations as a result of fragmentation of their habitat. High traffic volumes can lead to isolation of populations leading to inbreeding, which may adversely affect the health of isolated populations. Isolated populations may be so small that they become prone to local extinction events since they are not able to rely on immigration to supplement populations in the event that a large proportion of the population is lost to disease, predation or other perturbation.

The major effect on wood turtle populations from highways that cross the turtle habitat, is an increased potential for mortality within the population, especially the adults and recruiting sub-adults. Turtles cross roads in their travels and may, paradoxically, also be attracted to the roadsides as potential nesting, and foraging sites. This can result in direct vehicle strike-induced mortality, or in turtles picked up by passing motorists and taken away as pets or curiosities. Increased road access to previously remote areas increases the potential number of river and stream-based recreationists who may contribute to incidental removal of turtles.

The effects of habitat fragmentation, and to a limited degree direct turtle mortality, can be mitigated through the establishment of wildlife corridors. All of the sites having good wood turtle habitat along the proposed alignment are associated with rivers and streams. Wildlife corridors can be established at these locations through the use of bridges or open bottom culverts rather than the smaller, traditional culverts. Wildlife species including wood turtles can use these habitat strips as a means of moving from one side of the road to the other without leaving cover or exposing themselves to traffic. A bridge will be constructed at the

West River crossing. Pending a detailed pre-construction wood turtle survey at Stream Crossing No. 11, an open bottom culvert or similar type of structure may be employed at that location to adequately permit the passage of wood turtles if necessary.

The provision of wildlife corridors is particularly important on larger streams normally crossed by culverts. Adult wood turtles on small tributary streams feeding into the upper Canaan River of New Brunswick (n=3, 2 males, one female) were observed moving aquatically along streams crossed by culverts. Rather than swim through the culvert, the wood turtles were observed to leave the water upon approaching the culvert, clamber up the road embankment, cross the woods road and clamber down to the other side to re-enter the water. Observations of adult wood turtles moving along streams suggests that they are reluctant to pass through culverts (M. Macdonald, pers. comm. 2002). This behaviour, though anecdotal, suggests that these three wood turtles were following a traditional route in their territories and that they did not feel comfortable crossing through a dark narrow passage such as a culvert. While crossing a lesser travelled woods road is not very likely to result in turtle mortality, this behaviour on a major roadway very likely would.

At this stage of Project planning, it is not feasible to commit to specific design criteria for crossing structures. NSTPW will consult with NSDNR, prior to structure design, to develop an appropriate mitigative design that accomodates sensitive ecological features at these crossings including, but not limited to, wood turtles.

There is potential for populations to be significantly and adversely affected due to habitat fragmentation, direct mortality and removal during highway operations. The presence/absence of wood turtles and critical habitat along the highway alignment must be further defined through surveys. It is anticipated that the surveys and other aspects of a wood turtle risk management plan will be implemented to reduce the risk to insignificant levels.

5.4.6 Follow-Up and Monitoring

A wood turtle risk management program will be developed by NSTPW in collaboration with NSDNR at the South River, and the West River and its unnamed tributary at 8+150 (Stream Crossing No. 11) including:

- ongoing consultation with wood turtle specialists;
- pre-construction survey to further identify the presence/absence of wood turtles and critical habitat;
- design modifications as required (*e.g.*, open bottom culvert at Stream Crossing No. 11);
- wood turtle avoidance procedures for construction;
- post construction monitoring, if necessary; and
- public education program to reduce turtle removal.

For wood turtle populations potentially present in the Project area, including South River, which although it does not present good habitat at the crossing, is known to host wood turtles, a more detailed analysis of the size and extent of populations within or otherwise utilizing the affected areas would allow greater predictive ability regarding the threat posed by the operation phase of the Project. It is possible that any wood turtle population near or directly within the Project area is a building population, or, alternatively, already in decline or extirpated. A determination of actual wood turtle presence and the extent of any local population will require additional surveys conducted at the proper time of year.

A relatively complete understanding of the size and dynamics of a local population of wood turtles would require individual turtles being sought out, captured, marked, aged and sized, with monitoring conducted during three consecutive years (ACCDC 2002b). For a less certain, and minimal estimate of wood turtle population in the area, a single year survey of the habitat within a kilometre upstream and downstream of the crossing site could be undertaken. The habitat would be searched assiduously for wood turtles. The survey would be accomplished by walking or floating along the relevant stream sections during the early spring wood turtle activity period, mid April to late May, dependant on local onset of spring conditions and weather patterns, on sunny days into the afternoon. In early spring, local wood turtles hold close to the river systems in which they hibernated. Proximity to the river enables turtles to bask on the riverbank and yet still seek shelter in the water when cold weather threatens. In the spring, male wood turtles are also actively cruising the river in search of mating opportunities. There are few records of the species in the study area, and data from the area would in general be of value.

Wood turtles have chromosomal sex determination and generally display a 1:1 sex ratio. Thus an additional method (and one also useful to augment spring surveys) of estimating a wood turtle population is to identify potential nesting sites within the study area and monitor them to count nesting females. In Nova Scotia wood turtles nest from mid-June to early July. Nesting turtle surveys would occur at this time, at suitable nesting sites within a kilometre upstream and downstream of the proposed highway crossing, over a period of several days. This methodology does not show the presence of juveniles in the population.

The focus of the monitoring will be in the vicinity of Stream Crossing No. 11. Because a bridge is planned at the West and South Rivers, comprehensive monitoring is not required but incidental monitoring may be incorporated to increase the general knowledge of the species in the study area. If a large open bottom culvert or similar structure is planned at Stream Crossing No. 11, the concern with impending turtle passage at that location will also be lessened thus also reducing survey requirements.

5.4.7 Summary of Residual Environmental Effects Assessment

Provided the proposed mitigative measures are implemented, no significant adverse residual effects on rare herpetiles are anticipated from construction. However, highway operation through wood turtle habitat poses additional risk of mortality to any wood turtle population that may be present. With the implementation of the proposed mitigative measures, no significant adverse residual effects on wood turtles or other herpetile species is likely. Tables 5.16 and 5.17 summarise the residual environmental effects evaluation for rare herpetiles.

Table 5.16 Residual Environmental Effects Assessment Matrix
Rare Herpetiles (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing and grubbing of RoW near riparian zones, blasting excavation, sub-grade construction	• Direct mortalities (A) • Habitat loss (A)	• Wood turtle presence/absence surveys • Construction worker training and wood turtle relocation • Consideration of design modifications to structures (if necessary) at Stream Crossing No. 11 (*e.g.*, open bottom culvert) at West River and at South River to accommodate wildlife corridors	1 - 2	2	2 / 1	R	2	N	2

KEY

Magnitude: 1 = Low: i.e., specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: i.e., portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: i.e., affecting a whole stock, population or habitat, outside the range of natural variation

Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

Table 5.17 Residual Environmental Effects Assessment Matrix Rare Herpetiles (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Traffic/Presence of highway	• Direct mortality (A) • Removal of wood turtles (A) • Habitat fragmentation (A) • Inhibition of dispersal (A)	• Consideration (as part of construction) of wildlife corridors at stream crossings (South River, West River and Stream Crossing No. 11) • Public awareness campaign to decrease turtle strikes on road, and removal of turtles from habitat • Wood turtle surveys and implementation of a wood turtle risk management plan	2	1 - 2	5 / 6	1	2	N	2

Refer to Table 5.16 for Key.

5.5 Rare Mammals and Critical Habitat

Rare mammals are considered a VEC due to concerns with protecting species biodiversity. Rare species by definition, are of interest and warrant special consideration. Habitat critical for mammals that may not be rare (*e.g.*, white-tailed deer wintering habitat) but are valued by society, is also considered. This VEC includes all mammals considered to be rare in Canada (COSEWIC 2004) and Nova Scotia (ACCDC 2002a; NSDNR 2002a and NSDNR 2002b) that may potentially interact with the Project. It also includes mammals not considered to be rare, but which may be particularly sensitive to development (NSDNR 2002a) due to the fact that they are easily disturbed by human activity or tend to congregate in large concentrations (*i.e.*, hibernating bats) such that a substantial proportion of the population could be adversely affected by a particular development.

5.5.1 Boundaries

The spatial boundaries for assessment of rare mammals includes the study area as defined in Figure 5.4. Most mammals in Nova Scotia are non-migratory and are present in the study area year-round, therefore the temporal boundaries consider that mammals could be affected by road construction and operation continuously throughout the duration of Project activities. Temporal considerations also include sensitive periods such as hibernation and over-wintering behaviour.

5.5.2 Description of Existing Conditions

Information regarding the presence of rare mammals and sensitive mammal habitat within the study area was derived from existing data sources, interviews with staff of the Nova Scotia Department of Natural Resources (M. Pulsifer, pers. comm. 2002) and the Nova Scotia Museum of Natural History (A. Hebda, pers. comm. 2002) as well as a review of the Atlantic Canada Conservation Data Centre data base (ACCDC 2002a), the Atlas of Rare, Threatened and Infrequent Fauna of Nova Scotia (Fuller 1998) and field surveys, which were conducted between June 18 and 19 and August 20 and 23, 2002. Information gathered for the proposed South River crossing involved consultation of the Canadian Land Inventory, The Natural History of Nova Scotia and Dalhousie University's Technical Report for Maintenance of Beaches: Pomquet Antigonish County; A field survey was not conducted for the South River Impact Study (refer to Appendix E).

These information sources provide a good indication of the presence of large mammal species in the study area. Knowledge of the distribution of small mammals in the study area is less well known due to their secretive nature and the need to conduct intensive small mammal trapping programs to determine their presence in the area. Fortunately, many rare small mammals have very specific habitat requirements, which can be used to predict areas where they are likely to be found.

Habitat in the study area is relatively diverse but characterized by disturbed early successional habitats. The area is fairly heavily fragmented by primary and secondary roads, woods roads, agricultural land, electrical transmission lines, several large rivers and recent clear-cuts. Habitats present in the study area include: mixedwood, hardwood and softwood forest ranging in age from immature to mature, recent clear-cuts, tall shrub thickets, low shrub thickets, abandoned pasture, active agricultural land, residential areas, coniferous and mixedwood treed swamps, tall shrub dominated swamps, low shrub dominated swamp, freshwater marsh, brackish marsh, streams, large rivers, and estuary. Most forest along the route has been harvested within the past 20 years with forest stands greater than 20 years of age present along only 21 % of the proposed route.

No critical areas for mammals such as deer wintering areas are known to exist in the study area (M. Pulsifer, pers. comm. 2002; ACCDC 2002a). Table H.1 in Appendix H lists the mammal species (including binomials nomenclature) recorded along the proposed highway route during the field surveys as well as species expected to be found in the area. The species recorded in the study area are characteristic of woodland and riparian habitats. Visual sightings and the presence of abundant spoor suggested that white-tailed deer, red squirrel, varying hare, and raccoon were relatively abundant in the study area. Several large mammal species not recorded during the field surveys may be expected to be found in habitats present in the study area; these include red fox, ermine, river otter, American mink, and bobcat.

Seven small mammal species, including short-tailed shrew, star-nosed mole, American red squirrel, eastern chipmunk, deer mouse, red-backed vole, and meadow vole were recorded during the field surveys. Other small mammal species which may be expected to use habitats in the study area would include smoky shrew, cinerous shrew, little brown bat, northern flying squirrel, meadow jumping mouse, and woodland jumping mouse.

None of the species recorded in the study area are considered to be rare in Nova Scotia (ACCDC 2002a) or Canada (COSEWIC 2004). The Nova Scotia Department of Natural Resources has compiled lists of plant and animal species which are considered to be at risk of extinction or are particularly sensitive to human activities or natural events (NSDNR 2002a). Most of the listed mammals are also considered to be rare (ACCDC 2002a), however, four species are not considered to be rare but are considered to be sensitive including the mainland moose population, fisher, little brown bat, and northern long-eared bat. Given the high level of human activity in the study area, it is unlikely that fishers occur in this area. There was no evidence to indicate that moose use the study area. The relatively high density of white-tailed deer in the area would mean that there is a high potential for moose to contract brain worm (*Parelaphostrongylus tenuis*), an important cause of mortality in moose in Nova Scotia. Moose may occasionally wander through the area but are unlikely to be present on a permanent basis.

Little brown bat and possibly northern long-eared bats are likely to be present in the study area during the period from May to November. At this time they are widely dispersed and local populations are unlikely to be seriously adversely affected by activities associated with construction or operation of the proposed highway. Little brown bats and northern long-eared bats are most sensitive during the winter months when regional populations have congregated into a few locations. Disturbance at these sites can potentially result in the deaths of large numbers of bats. There are no known hibernation sites such as caves or mines in the study area so these species are unlikely to be present during the period from November to May when they are hibernating. Karst topography is present in the vicinity of Antigonish although none was found within the study area. The sink holes associated with karst topography often form over solution caves, which can provide hibernation sites for a number of bat species including little brown bat and northern long-eared bat.

5.5.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect occurs when the population of a mammal species is sufficiently affected to cause a decline in abundance and/or change in distribution beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return the population to its former level within several generations.

A **positive** environmental effect occurs when Project activities help to increase species populations and/or diversity or enhance habitat.

5.5.4 Potential Issues, Interactions and Concerns

Rare or sensitive mammal populations could potentially be affected by habitat loss and disturbance. For small mammals, such as shrews, habitat loss is likely to result in direct mortality of individuals since they stay in close proximity to cover. Larger mammals are less likely to suffer direct mortality since they will tend to flee the area as soon as they detect humans.

Noise, visual stimuli, or scents associated with construction activity or operational activities may potentially disturb rare mammals. However, due to widespread development and human activity in this area, it is likely that many of the mammal species would be relatively tolerant of Project activities.

Operation of the highway will result in an increased incidence of roadkill among mammal species present in the study area. The number of mammals killed by collisions with automobiles can be expected to average approximately 3/km/year based on roadkill data collected for Highway 102 over a two year period (M. Crowell, unpublished data). As such, the total number of mammals killed along the proposed highway each year is estimated to be approximately 45 animals. The species which can be expected to account for approximately 80 % of the roadkills are raccoon, porcupine and striped skunk. The number of deer struck each year is estimated to be two animals per year; this is probably an underestimate since the roadkill surveys were conducted in 1993 and 1994 during a period when white-tailed deer populations in Nova Scotia were low. The incidence of deer roadkills along the proposed highway may be as high as 10 during a year of peak deer abundance.

The presence of the highway will also cause habitat fragmentation. Some mammal species may be reluctant to cross the road. Species most reluctant to cross the road would be those particularly sensitive to anthropogenic activity and small mammals such as shrews, voles and mice. Given the proximity of the proposed road to existing areas of human occupation, it is unlikely that sensitive species are present. Small mammal populations could be adversely affected by habitat fragmentation. Populations isolated from other populations in small habitat fragments are more prone to local extirpation since these fragments may be too small to support a population. Fragments may be large enough to support a population, but may not be large enough to provide enough animals to rebuild the population should it be heavily impacted by disease or predators. Isolation of the fragment can also impair the immigration of new animals into an area where a local population has been extirpated. Impaired immigration can also adversely affect populations by restricting gene flow between populations leading to inbreeding.

Field surveys and a review of existing data sources suggest that no rare mammals and/or critical habitat are present in the study area.

5.5.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.5.5.1 Construction

No rare, at risk or potential at risk mammal species are known in the study area. Two sensitive species, the little brown bat and northern long-eared bat are likely to be present in the study area during the spring, summer and early fall when they are not particularly sensitive to human activities; they are not present during the late fall and winter when they are particularly sensitive to human activities. Construction of the highway is therefore not expected to adversely affect rare or sensitive mammals. There will be habitat loss and sensory disturbance associated with noise during Project construction as well as the potential mortality of small mammals. However, these effects are not likely to significantly affect mammal populations or critical mammal habitat. Mitigative measures are limited to minimizing vegetation clearing as far as practical during RoW preparation to preserve habitat.

5.5.5.2 Operation and Maintenance

Since no rare mammal species are likely to be present in the study area, and the two sensitive species, the little brown bat and northern long-eared bat, are only expected to be present in the study area when they are not particularly sensitive to human activities, operation and maintenance activities are not expected to adversely affect rare or sensitive mammals. No mitigation will be required for these particular species.

The number of roadkills predicted for the proposed highway is unlikely to have any significant effect on regional populations of mammals; however, where possible, mitigation will be implemented to reduce the number of animals killed in collisions with automobiles. One method to reduce the incidence of roadkill is a longer span than normally required at watercourses and road crossings. This would allow the preservation of a fringe of natural vegetation on either side of the watercourse or road which could be used as a travel route by wildlife.

The study area does not provide habitat for rare small mammal species and the species present or expected to be present are relatively abundant in the area such that isolation of small populations in habitat fragments will not significantly affect regional populations of these species. Nevertheless, it is proposed that mitigative measures be employed to reduce the potential for adverse effects associated with habitat fragmentation. The use of wildlife underpasses would help to connect isolated habitat fragments. The need for and design of wildlife underpasses will be considered after the location of the alignment and interchanges are finalized and after consultation with NSDNR.

5.5.6 Follow-Up and Monitoring

No follow-up studies or monitoring are proposed.

5.5.7 Summary of Residual Environmental Effects Assessment

Provided the proposed mitigative measures are adhered to, there is not likely to be any significant adverse residual environmental effects on rare mammals and critical habitat. Tables 5.18 and 5.19 summarise the residual environmental effects evaluation for rare mammals and critical habitat.

Table 5.18 Residual Environmental Effects Assessment Matrix Rare Mammals and Critical Habitat (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing, grubbing, blasting, excavation and sub-grade construction	• Habitat loss (A)	• Minimize vegetation clearing as practical for RoW preparation	1	3	2 / 6	I	2	N	3
	• Direct mortality of small mammals (A)	• No mitigation recommended	1	3	2 / 6	R	2	N	3
	• Sensory disturbance (A)	• No mitigation recommended	1	3	2 / 6	R	2	N	3

KEY

Magnitude: 1 = Low: *i.e.*, specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: *i.e.*, portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: *i.e.*, affecting a whole stock, population or habitat, outside the range of natural variation

Geographic Extent: 1 = <500 m^2; 2 = 500 m^2 -1 km^2; 3 = 1-10 km^2; 4 = 11-100 km^2; 5 = 101-1000 km^2; 6 = >1000 km^2

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

Table 5.19 Residual Environmental Effects Assessment Matrix
Rare Mammals and Critical Habitat (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Traffic	• Sensory disturbance (A)	• No mitigation recommended	1	3	5 / 6	R	2	N	3
	• Direct mortality associated with vehicle collision (A)	• Consider longer bridge spans to preserve vegetative fringe for wildlife travel routes	1	3	5 / 6	R	2	N	2
	• Habitat fragmentation (A)	• Consider longer bridge spans to preserve vegetative fringe for wildlife travel routes	1	3	5 / 6	R	2	N	2

Refer to Table 5.18 for Key.

5.6 Rare and Sensitive Birds

Rare and sensitive bird species are considered a VEC due to concerns with protection of species biodiversity and protection of other species of interest. Issues of concern are limited in this assessment to rare bird species, and bird species sensitive to human activities, such as raptors. Rare species by definition, are of interest and often warrant special consideration. Raptors (*e.g.*, eagles, hawks, falcons) are generally sensitive to human disturbances, especially during their breeding period.

5.6.1 Boundaries

Spatial boundaries for the assessment of rare and sensitive birds primarily include the study area as indicated by Figure 1.1. Most bird species in Nova Scotia are migratory, though some are considered resident. Temporal boundaries are therefore variable, as some species may be present year-round while others may occupy habitat in the vicinity of the Project only during a particular point in their life (*e.g.*, migration period). The assessment considers both construction and operation phases of the Project, on a year-round basis. Other temporal considerations include sensitive periods during bird life-cycles, in particular the breeding season (predominantly from May to August) when birds are particularly vulnerable to disturbance.

5.6.2 Description of Existing Conditions

Information regarding bird species in the study area were derived from the Atlas of Breeding Birds of the Maritime Provinces data base (breeding bird atlas) (Erskine 1992) and a breeding bird survey. In addition, the ACCDC was consulted to determine if they had any records of rare bird species in the area. Staff of NSDNR (M. Pulsifer, pers. comm. 2002) and the Nova Scotia Museum of Natural History (A. Hebda, pers. comm. 2002) were contacted to determine if any rare or sensitive bird species had been reported in the area. A bird survey was conducted October 1, 2000 for the South River Impact Study. Additional information was gained from the surveyors' personal records, historic Christmas Bird Count data, and the breeding bird atlas (refer to Appendix E).

The breeding bird atlas data is of limited usefulness due to the fact that data is recorded in 10 km x 10 km census squares, making it impossible to establish whether a particular species has been observed in close proximity to the study area. Nevertheless, it does provide an indication as to which species may be expected in the study area. Should any rare or sensitive bird species be recorded in the atlas square, field surveys may be focussed on the preferred habitat of these species to increase the efficiency of the field survey.

The breeding bird survey was conducted along the entire alignment between June 18 and 19, 2002. During the survey the flagged centerline for the proposed RoW was used as a transect line. The transect line was walked and all birds observed or heard singing along the route were listed and the numbers of each species in each habitat present along the transect were recorded.

The breeding status of each species was determined. Species identified but not exhibiting signs of breeding were classed as non-breeders. Species observed or heard singing in suitable nesting habitat were classified as possible breeders. Species exhibiting the following behaviours were classed as probable breeders:

- courtship behaviour between a male and female;
- birds visiting a probable nesting site;
- birds displaying agitated behaviour; and
- male and female observed together in suitable nesting habitat.

Species were confirmed as breeding if any of the following items or activities were observed:

- nest building or adults carrying nesting material:
- distraction display or injury feigning;
- recently fledged young;
- occupied nest located; and
- adult observed carrying food or faecal sac for young.

The population status of each species was determined from existing literature. Lists of provincially uncommon or rare birds were derived from ACCDC (2002a) while nationally rare or endangered species were derived from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2004). A list of birds protected under the *Endangered Species Act* in Nova Scotia were derived from NSDNR (2002b). The Lists of birds considered to be sensitive to human activity in Nova Scotia were derived from NSDNR's General Status Ranks of Wild Species in Nova Scotia (2002a).

Table H.2 in Appendix H presents a list of birds recorded for the four atlas squares within which the study area is situated. Table H.3 in Appendix H presents the list of birds recorded along the proposed highway RoW during the breeding bird survey and their breeding status. Table H.4 in Appendix H presents the numbers of each species recorded in the various habitat types present along the proposed route.

A total of 143 species of bird have been recorded in the general area according to the breeding bird atlas. These include 18 species which may be uncommon or rare in the province of Nova Scotia or may be sensitive to human activities. One of the species recorded in the atlas squares, Piping Plover, is considered to be endangered in Canada (COSEWIC 2004). It is also listed as an endangered species in the *Nova Scotia Endangered Species Act*. Piping Plovers breed on sandy beaches. This habitat type is not present along the proposed highway route so it is highly unlikely that this species would be present. No Piping Plovers were recorded during the breeding bird survey.

Four of the species recorded in the four atlas squares are considered to be rare (S2 - rare throughout its range in the province; 6 to 20 occurrences or few remaining individuals; may be vulnerable to extirpation due to rarity or other factors) in Nova Scotia by ACCDC . These include Whip-poor-will, Wood Thrush, Warbling Vireo, and Philadelphia Vireo. The Nova Scotia populations of these species are considered to be secure (NSDNR 2002a). All of these species are common elsewhere in their ranges and Nova Scotia represents the edge of their distribution. Whip-poor-will, Wood Thrush, and Warbling Vireo are southern species which reach their northern range limit in the Maritime Provinces. Philadelphia Vireo is a boreal species which reaches its eastern range limit in Nova Scotia. Suitable habitat was present along the proposed highway route for Philadelphia Vireo which often inhabit young hardwood and mixedwood stands that are abundant along the proposed route. Wood Thrush are typically found in moist mature deciduous forest which is a rare habitat type along the proposed route. Warbling Vireos also prefer mature deciduous forest but will also nest in riparian forest, thickets and gardens. Thickets are abundant along the route so this species could occur along the route. In Nova Scotia, Whip-poor-wills are typically found in dry open hardwood stands. This type of habitat is not present along the proposed route so it is unlikely that this species would be present along the proposed route. None of these four species were noted on or near the proposed highway route during the breeding bird survey.

Four species listed as rare to uncommon (S2S3 - population status of the species is not well documented) by ACCDC were recorded in the four atlas squares. These species included Red-breasted Merganser, Eastern Phoebe, Vesper Sparrow, and Nelson's Sharp-tailed Sparrow. The Nova Scotia populations of Red-breasted Merganser and Eastern Phoebe are considered to be secure (NSDNR 2002a). Vesper Sparrow and Nelson's Sharp-tailed Sparrow are listed as yellow species by NSDNR (2002a) indicating that the Nova Scotia populations of these species are sensitive to anthropogenic activities or natural events. Vesper Sparrows declined in abundance in Nova Scotia after the 1940s and numbers have remained low. This species typically breeds in agricultural land with a decided preference for blueberry fields which provide the open habitat required by this species (Erskine 1992). No blueberry fields are present along the proposed highway route. Agricultural lands present include pasture, hay fields and grain fields which are not frequently used by breeding Vesper Sparrows. No Vesper Sparrows were observed or heard during the breeding bird survey.

Nelson's Sharp-tailed Sparrow breeds in salt marshes and brackish marshes. The amount of salt marsh habitat in Nova Scotia has been greatly reduced as a result of past dyking of salt marshes to provide agricultural land. Modern activities such as flooding of marshes and disturbance by ATVs also adversely affect this species (NSDNR 2002a). Future global sea level rises could also impact this species by destroying salt marsh habitat. Brackish marsh habitat is present at the proposed South River crossing site. This area was surveyed during both breeding bird surveys (October 2000; June 2002) and a Nelson's Sharp-tailed Sparrow was heard during the South River study (October 2000) and was observed and heard singing in this habitat during the 2002 survey. Figure 5.4 indicates the area where the Nelson's Sharp-tailed Sparrow was found; most of this area is located to the north of the highway RoW. Approximately 25% of this area is located within the RoW and approximately 5% is located within the footprint of the proposed South River bridge.

In Nova Scotia, Red-breasted Mergansers breed on small coastal islands and sand bars. Nests are situated on the ground near the water. Along the proposed highway route suitable nesting habitat is found near the mouth of the South River on several small islands located north of the proposed bridge. The low peninsula over which the bridge passes may also provide suitable nesting habitat; however, since it is joined to the mainland it may not be preferred nesting habitat since predators such as racoons, striped skunk, red fox, coyote and domestic cat can access this area relatively easily. No Red-breasted Mergansers were observed during the breeding bird survey.

Eastern Phoebe typically nest in open woodlands along water courses or in farmland with scattered trees. They often build their nests inside abandoned buildings or culverts or on bridges. Habitat of this type is present at the West River and South River crossing sites. Eastern Phoebe were not detected at either of these sites during the breeding bird survey.

Five species considered by ACCDC (2002a) to be uncommon in Nova Scotia (S3 - uncommon throughout its range in the province, or found only in a restricted range, even if abundant at some locations; 21 to 100 occurrences) have been recorded in the four atlas squares within which the proposed highway is located. These include Northern Goshawk, Common Tern, Arctic Tern, Bobolink and Northern Oriole. All of these species, with the exception of the Northern Oriole, are yellow listed by NSDNR indicating that the Nova Scotia populations of these species are sensitive to anthropogenic activities or natural events. The Northern Oriole is considered to be secure in Nova Scotia. Northern Goshawks are threatened by disturbance during the nesting season and loss of suitable forest nesting habitat. Northern Goshawks typically nest in mature hardwood or mixedwood forests remote from human activity. Little suitable forest is available along the proposed highway route and the route runs adjacent to areas heavily populated by humans. It is unlikely that this species nests along the proposed highway route. No Northern Goshawks were detected during the breeding bird survey.

Common and Arctic Tern populations in Nova Scotia are adversely affected by disturbance at nesting colony sites, predation of eggs and young by gulls and loss of prime nesting sites to gulls which typically begin nesting earlier than terns. Common and Arctic Terns generally nest on coastal islands, sand spits, beaches and occasionally salt marshes. Potential nesting sites exist at the mouth of the South River on small islands in the estuary. No evidence of tern nesting activity was observed on these islands during the breeding bird survey.

Bobolinks generally nest in hay fields and pastures. The Bobolink population in Nova Scotia has decreased substantially in recent years. The causes of this decline are not well understood but may relate to changes in agricultural practices such as the use of insecticides, changes in management of hay fields, loss of hay fields to other land uses, and the practices of spring burning and mowing. The proposed highway passes through six areas where agricultural grasslands are present. During the breeding bird survey Bobolink were recorded at two of these areas. A total of three singing males were detected, two at South River and one at North River. In all instances the areas where Bobolinks were recorded were outside of the RoW and the footprint of the highway.

Northern Orioles are uncommon in Nova Scotia; however, the Nova Scotia population is considered to be secure. Nova Scotia is the northern limit of the range of this species. Northern Orioles generally nest in riparian forests or in tall shade trees in towns and cities. Elms are frequently used as nest trees by Northern Orioles since they prefer to attach their hanging nests to pendulous branches. In the past the West River crossing site would have provided ideal habitat for Northern Orioles since it contained a substantial number of large open grown white elms (*Ulmus americana*). However, over the past 20 years Dutch elm disease has killed all of the large elms reducing its suitability as Northern Oriole nesting habitat. No Northern Orioles were detected during the breeding bird survey.

Five species listed as uncommon to common (S3S4 - population status uncertain) by ACCDC were recorded in the four atlas squares or during the field surveys. These species included Merlin, Black-backed Woodpecker, Boreal Chickadee, and Rusty Blackbird. All of these species are considered to be secure in Nova Scotia (NSDNR 2002a).

Merlins usually inhabit open areas or the edges of forests. They generally nest in trees, often in abandoned crow nests. Occasionally they may nest in tree cavities. In areas where trees are not plentiful Merlins may nest on cliffs or on the ground. Merlins are relatively unwary of humans and occasionally nest in close proximity to humans. A successful Merlin nest has been found in Point Pleasant Park in Halifax and another was found on the Edmunds Grounds on the outskirts of Halifax (Tufts 1984). During the breeding bird survey, an agitated Merlin was observed near 4 + 000. The Merlin was initially observed sitting on an electrical transmission line. When the bird noticed the biologists emerging from the forest it became agitated and flew into a small stand of mature spruce and fir at 4 + 075. The bird scolded the biologists for several minutes from this location then disappeared. The agitated behaviour of the Merlin suggested that there was a nearby nest. The forest stand from which the Merlin scolded the biologists was searched but no nest was found. The nest site is likely to have been situated either approximately 300 m south of the area where the bird was first observed in a stand of mature softwoods near Tamara Drive or in mature mixedwood forest located north of 4 + 075. Merlins typically establish a new nest site each year so the nest location can be expected to shift from year to year.

Black-backed Woodpeckers are generally associated with coniferous forests. They usually nest in mature softwood stands but are sometimes found nesting on islands of softwood forest in clear-cuts. Black-backed Woodpeckers are attracted to dead or dying coniferous trees. They typically pry off the bark of these trees while foraging for insects. Their feeding activities leave characteristic piles of bark scraps which can be used to establish their presence in an area. This sign was observed during the breeding bird survey. It was not possible to determine from this evidence if Black-backed Woodpeckers were present near the proposed road during the breeding season or if they only occasionally forage in the area. Black-backed Woodpeckers are noted for their propensity to wander widely outside of the breeding season. Mature softwood forest which might provide suitable nesting sites was present in the general area but was quite rare.

Boreal Chickadees are also associated with coniferous forests. This species is a cavity nester which often nests in cavities in relatively small trees. Suitable habitat for Boreal Chickadees is present at a number of locations along the proposed highway route. This species was not recorded in any of the atlas squares (Erskine 1992) but was recorded at various locations along the route, in immature softwood forest and mature mixedwood forest, during the breeding bird survey. One of the Boreal Chickadees noted during the survey was observed carrying food indicating that there was a nearby nest. This bird was observed near Chainage 8 + 000. Although Boreal Chickadees are fairly common, the results of the breeding bird atlas suggests that their numbers have decreased in recent years probably as a result of heavy harvesting of coniferous forests.

Rusty Blackbirds are typically associated with swamps along sluggish streams or stillwaters. They are most abundant in the interior of the province and are generally found in areas remote from human settlement. Typical Rusty Blackbird breeding habitat was not encountered along the proposed highway route and no Rusty Blackbirds were recorded during the breeding bird survey.

The Black-billed Cuckoo is a southern species which reaches its northern range limit in south central Canada to the Maritime Provinces. It is a species of woods edges, thickets and hedgerows. In the northern parts of its range, the population varies greatly from year to year with outbreaks of tent caterpillars. Black-billed Cuckoo was recorded during the breeding bird survey but was not previously recorded in the atlas squares within which the proposed route is located (Erskine 1992). Two individuals were recorded during the survey, one more than 500 m from the RoW near South River, and another heard at close range at West River. The exact location of the South River bird was not pinpointed, however it was heard at quite a distance from the RoW, and would not likely be affected by the Project. The West River bird was heard within the RoW at 5 + 580 (Figure 5.4). The Black-billed Cuckoo was heard singing from an alder thicket located on a slope overlooking the west bank of the West River. The alder thicket was located immediately adjacent to an occupied house. The bird was heard singing on a number of occasions within the same thicket suggesting that a nest might be located nearby. Suitable nesting habitat was abundant along much of the riparian zone of the West River as well as areas of the riparian zone of the South River upstream of the existing Highway 104 bridge.

Several raptor species other than Merlin were recorded during the breeding bird survey. These included Bald Eagle, Osprey, Red-tailed Hawk, and Barred Owl. The South River Impact Study indicated that two bald eagle nests were located within 2 km of the study site and that adults forage at the study site throughout the nesting season and for as long as the river is not frozen (Neill and Gunter Ltd. 2001). Two Bald Eagles were observed at the proposed South River crossing site during the 2002 survey. Bald Eagles are frequently observed near the West River crossing site as well, particularly during the spring and early summer when they forage for fish in the river. There was no evidence of any Bald Eagle nests near the proposed highway route. Four Bald Eagle nests are located within 2 km of the proposed highway. There are three active nests located north of the RoW at the mouth of the South River. The nearest active nest is 1 km from the edge of the proposed roadway. There is an inactive Bald Eagle nest which is situated 430 m from the edge of the proposed highway located near 2+500. NSDNR recommends the establishment of a 400 m buffer zone around the nest site to prevent disturbance of nesting Bald Eagles. All of these nest sites are more than 400 m from the proposed highway and should not be adversely affected by highway construction.

Two Osprey were observed during the breeding bird survey. Both were observed flying over the proposed route near the South River crossing site, which is frequently used as a foraging area for Osprey and Bald Eagles. Two Osprey nests were noted during the wetland surveys conducted in mid-August. Both nests were situated on power poles located south of the proposed highway RoW. Neither nest was occupied at that time but were in good condition suggesting that they had probably been active in 2002. Osprey typically use the same nest continuously so it is likely that these nests will be used in the future. These nests correspond to two of six Osprey nests documented by NSDNR (M. Pulsifer, pers. comm. 1997). Figure 5.4 presents the locations of these nests. The nearest nest is located approximately 200 m from the edge of the proposed highway at 3 + 300. The second closest nest is 320 m from the edge of the highway at 8 + 650 and the third closest nest is located 370 m from the edge of the highway at 9 + 100. The remaining three nests are more than 500 m from the edge of the proposed highway. Osprey, particularly those nesting in developed areas, are quite tolerant of anthropogenic activities. Osprey nesting away from regular human activity can be sensitive to human activity. A buffer zone of 100 m is generally adequate to protect Osprey nests from disturbance during the nesting season. It is unlikely that construction and operation of the proposed highway will cause abandonment of these nest sites.

One Red-tailed Hawk was observed during the breeding bird survey. This bird was observed capturing a small mammal in a pasture at 7 + 100. The bird left the area when it spotted the biologists. It did not display any agitated behaviour suggesting that its nest was not located nearby. Red-tailed Hawks generally scold intruders that approach their nests too closely.

One Barred Owl was flushed from its roost in a mature softwood stand at 8 + 200. The owl was observed during a wetland survey conducted in mid-August. Barred Owls begin nesting in late March or early April and most chicks have fledged by the end of June. Given the timing of the observation it is unlikely that the Barred Owl was nesting.

Table H.3 in Appendix H presents the results of the breeding bird survey. A total of 79 bird species were recorded during the survey. The most abundant species in decreasing order of abundance were Song Sparrow, Common Grackle, American Robin, Cedar Waxwing, Red-eyed Vireo, Alder Flycatcher, White-throated Sparrow, American Goldfinch, European Starling, Yellow Warbler, Common Yellowthroat, American Crow, and Black-capped Chickadee. Together these 13 species accounted for 58 % of the total of all of the birds recorded during the breeding bird survey. Most of these species are characteristic of disturbed early successional habitats such as clear-cuts, shrub thickets, regenerating forest and residential areas. This reflects the highly disturbed nature of the landscape through which the proposed highway passes. Only 28 % of the route passes through relatively undisturbed forest (stands aged 20 + years) or wetlands. Forty-seven percent of the route passes through regenerating forest (stands 10 to 20 years old), tall shrub thickets or Christmas tree operations. The remaining 24 % of the route passes through young clear-cuts (stands < 10 years old), abandoned pasture, active agricultural land or residential areas.

In descending order, the habitats which had the largest tallies of birds were immature hardwood stands, tall shrub thickets, immature mixedwood stands and tall shrub-dominated swamps. Half of the birds recorded during the survey were recorded in these habitats. This in turn is attributable to the abundance of these habitat types along the route. These habitats also had high species richness compared to other habitat types. Tall shrub swamp had the highest species richness, followed by immature mixedwood forest, immature hardwood forest, mature mixedwood forest, tall shrub thickets, and mature softwood forest. The high species richness associated with the early successional habitats such as immature mixedwood forest, immature hardwood forest and tall shrub thickets is at least partially attributable to the abundance of these habitats along the route. Compared to other early successional habitats they are fairly structurally complex which attracts a wide range of species. This would also contribute to the high species richness of these habitats. Mature mixedwood forest and mature softwood forest habitats have high species richness in spite of the fact that they occupy only about 21% of the route. High species richness in these habitats would largely be attributable to the structural complexity of these mature forests which provides feeding and nesting opportunities for a wide range of bird species.

The results of the bird survey conducted at the proposed South River crossing are included in Table C2 of Appendix C of the South River Impact Study (Appendix E) (Neill and Gunter Ltd. 2001).

5.6.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect occurs when the Nova Scotia population of a bird species is sufficiently affected to cause a decline in abundance and/or change in distribution beyond which natural recruitment would not return the population(s), or any populations or species dependent upon it, to its former level within several generations.

A **positive** effect occurs when Project activities help increase Nova Scotia species populations and/or diversity.

5.6.4 Potential Issues, Interactions and Concerns

The results of the breeding bird survey conducted along the proposed alignment indicates that there was likely a Merlin nest (2002) located in mature forest adjacent the proposed RoW near 4 + 075, and a high probability that a Black-billed Cuckoo was nesting within the RoW adjacent to a house at 5 + 580 near West River in 2002. Merlins are relatively unwary of humans and occasionally nest in close proximity to humans. Merlins typically establish a new nest site each year so the nest location can be expected to shift from year to year. The Black-billed Cuckoo that nested within the RoW in 2002 would be displaced following construction of the highway. There is suitable nesting habitat for Black-billed Cuckoo in neighbouring habitats.

The breeding season is generally the most critical period for bird species, since eggs and nestlings cannot move from the source of disturbance. Potential adverse effects may result from destruction or permanent abandonment of a nest or increased predation of eggs and young during temporary abandonment. Birds in general can also be affected by habitat loss, fragmentation and sensory disturbance as well as the creation of edge habitat, as a result of construction of the proposed highway.

Construction of the proposed highway will result in the creation of habitat edge. Habitat edge has both positive and negative implications for birds. Habitat edges often support a large number and variety of bird species. Edges also tend to attract generalist predators such as raccoons, red fox, coyote, dogs, cats, crows and jays. They may also attract Brown-headed Cowbirds (*Molothrus ater*), a nest parasite of passerine (perching) birds. The presence of high concentrations of predators and Brown-headed Cowbirds along habitat edges can result in these areas becoming reproductive sinks in which large numbers of birds attempt to breed but have poor breeding success. The deleterious effects of habitat edge may extend up to 600 m into the forest interior (Yahner 1988).

Linear developments such as highways also have the potential to fragment habitats. Some species may be reluctant to cross roadways causing populations to be isolated in habitat fragments. These fragments may be too small to support a population of a particular species particularly if it requires forest interior habitats for survival. Physical isolation of a population combined with the deleterious effects of edge may eliminate species in habitat fragments.

During the operational phase of the Project, traffic on the proposed highway could disturb birds nesting or foraging in habitats near the new road. Direct mortality could result as a result of collisions with vehicles. Maintenance activities could disturb birds located adjacent to the highway. Maintenance activities, which will occur in conjunction with the operation of the highway, are unlikely to cause any unique disturbance to birds, beyond those effects related to operational traffic. Potential effects and mitigation associated with malfunctions and accidental events are discussed in Section 7.

5.6.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.6.5.1 Construction

A number of activities (*i.e.*, clearing and grubbing) associated with road construction could interact with sensitive bird species. During construction, potential effects include habitat loss, noise and related disturbance and the creation of habitat edge. Clearing and grubbing will result in the removal of trees, shrubs and other ground cover such as herbaceous plants, brush piles and dead falls that provide nesting habitat for various bird species. This will result in the displacement of birds nesting in these areas. The effects of clearing and grubbing are most severe when these activities are conducted during the period when most bird species are breeding (predominantly from May to August). Clearing and grubbing at this time will result in the direct mortality of eggs and unfledged nestlings. The intentional killing of migratory birds or the destruction of their eggs, or young is an offence under the *Migratory Birds Convention Act*. Clearing and grubbing outside of the breeding season will deny birds suitable habitat; however, birds have the option of establishing nests in adjacent areas. NSTPW will conduct clearing during the winter which should avoid many adverse effects on nesting birds. In addition, the width of RoW cleared will be as narrow as practical to reduce the amount of lost habitat.

Nelson's Sharp-tailed Sparrow was found in marsh habitat on the South River both during the bird surveys conducted for the South River Impact Study (2000) and during the bird survey conducted along the entire proposed alignment (2002). This species is considered to be sensitive to anthropogenic activity in Nova Scotia largely due to the loss of breeding habitat through conversion of salt marsh to agricultural land. Only one Nelson's Sharp-tailed Sparrow was recorded during the breeding bird survey at South River. Approximately 25 % of the area in which the bird was heard and observed falls within the highway RoW and approximately 5 % of this habitat is found within the footprint of the bridge. Construction of the bridge could result in some habitat loss as a result of bridge pier construction. Construction activity could also result in disturbance to Nelson's Sharp-tailed Sparrows using habitat adjacent to the bridge while it is under construction. A Nelson's Sharp-tailed Sparrow monitoring study conducted in a salt marsh adjacent to the Confederation Bridge fabrication yard revealed that Nelson's Sharp-tailed Sparrows shifted their distribution towards the centre of the marsh in response to construction activity (JWEL 1998). Evidence suggested that this shift in distribution was attributable at least partially to displacement of red foxes from the pasture habitat that the fabrication yard was constructed on. These displaced foxes foraged more frequently around the margins of the marsh forcing ground nesting Nelson's Sharp-tailed Sparrows to abandon the marsh margins. Another Sharp-tailed Sparrow monitoring study conducted in Moncton near the Gunningsville Bridge indicated that Nelson's Sharp-tailed Sparrows were not deterred from using habitats immediately adjacent to a very busy highway bridge (JWEL 2001).

Several mitigative measures can be used to minimize the effects of bridge construction on Nelson's Sharp-tailed Sparrow. Bridge construction activities at this site, particularly pier construction, will be conducted outside of the breeding season for this species (early June to late August). Construction of the piers will be planned such that the amount of wetland habitat disturbed by construction activity is minimized. The minimum amount of space required to safely conduct the work will be identified prior to the onset of construction and marked on the construction site to prevent accidental incursions outside of the defined construction area. Vehicle access to the construction area will be from the south away from the preferred habitat of Nelson's Sharp-tailed Sparrow.

Bobolinks are also considered to be sensitive to human activities. Changes in agricultural practices and other land use practices such as the burning of grass are believed to be factors contributing to the decline in Bobolink populations in Nova Scotia. Bobolinks were heard singing at two locations (West River and South River) during the breeding bird survey suggesting that they may nest in the area. The areas where they were heard were outside of the proposed RoW. No loss of Bobolink habitat is expected. This species typically nests in agricultural areas in close proximity to humans. Bobolinks are often observed singing from wires and fences on the sides of roads suggesting that they are not easily disturbed by human activities. Construction activity is unlikely to cause any serious sensory disturbance effects in this species. No significant adverse effects are expected for this species as a result of construction activity and no mitigative measures are proposed.

Black-billed Cuckoo will be directly affected by habitat loss. The likely nesting location found in 2002 is probably within the cleared RoW. Construction of the highway along the presently proposed alignment will likely result in the loss of the nest site. Other suitable habitat is present nearby. Clearing activities will be conducted during the winter, thereby avoiding the destruction of nests, eggs or young of this species. No other mitigation is proposed for this species which is considered secure in Nova Scotia.

Boreal Chickadees were recorded at several locations along the route. Although no nest was found, evidence was collected which indicated that this species breed on or near the RoW. Boreal Chickadees nest in cavities in live trees or snags in coniferous or occasionally mixedwood forest. Suitable nesting habitat is present at various locations along and adjacent to the proposed route. The Nova Scotia Boreal Chickadee population is considered to be secure. Clearing of the RoW will occur during the winter months thereby eliminating the possibility of destroying active Boreal Chickadee nests. No other mitigative measures are proposed.

Merlins will build new nests each year, and may use neighbouring mature coniferous forest habitat. Given that the apparent nesting habitat is reasonably close to human habitation, the Merlin pair is expected to be tolerant of human activities, and therefore there is a low probability of affecting the breeding of Merlins in this area. The effects of highway construction on nesting birds will be reduced by scheduling RoW clearing outside of the breeding season for this species (mid-May to early August).

Three Osprey nests have been recorded within 500 m of the proposed highway. The closest nest is located approximately 200 m from the edge of the road. A buffer zone of 100 m is generally adequate to protect breeding Osprey (NSDNR unpublished Osprey habitat management guidelines). Given the distance from this nest site, adverse effects on Osprey nesting activity at this site are not anticipated. In order to ensure that the nests are not disturbed during construction, no construction related activity will be permitted within 200 m of any of these nest sites.

Habitat fragmentation may adversely affect populations of birds living adjacent to the proposed RoW but will not significantly affect regional populations. The study area has already been subjected to habitat fragmentation as a result of forest harvesting activity, agricultural activity, housing developments and linear developments including roads. Approximately 47 % of the proposed RoW passes through disturbed early successional habitats such as clear-cuts, shrub thickets and regenerating forest. Another 24 % of the RoW runs through areas affected by agricultural or residential land use. The adverse effects of habitat fragmentation can be reduced by routing the RoW through heavily disturbed areas such as recent clear-cuts wherever possible. The proposed highway route has largely accomplished this goal since 71 % of the route passes through recently disturbed habitats.

Due to the apparent habitation and habituation of the bird species of concern to existing human activity, the effects of habitat loss and fragmentation, and sensory disturbance during Project construction is not likely to have a significant adverse environmental effect on rare and sensitive bird populations.

5.6.5.2 Operation and Maintenance

During the operation phase, birds could be affected by disturbance caused by traffic and direct mortality associated with collisions with automobiles. Several studies have shown that disturbance associated with automobile traffic can have an adverse effect on bird abundance and breeding success. A study of terrestrial bird abundance, species composition and breeding success in forested habitats adjacent to a busy highway in New Brunswick (JWEL 1998) revealed a reduction in bird abundance of 18 to 25 % in plots located 100 and 200 m away from the road relative to control plots 500 m from the road. Evidence of breeding activity was reduced by 34 to 39 % relative to control plots. These reductions were not statistically significant. A similar study conducted in the Netherlands revealed a reduction in the number of singing males from 3.3/ha in control plots to 2.1/ha in areas within 200 m of a highway (Reijnen and Foppen 1994). These data indicate that disturbance associated with operation of the road will have a measurable adverse effect on local populations but is not expected to significantly adversely affect regional populations. Reijnen and Foppen (1994) noted that the degree of disturbance to birds by highway traffic was best correlated with noise levels. As such, the best means of mitigating the adverse effects of traffic on birds is to reduce noise levels. There is no practical or effective way in which to do this over a stretch of highway this long. Noise barriers would be prohibitively expensive and a reduction in speed limits within practical limits would have only a minor effect on noise levels. By way of example, reduction of the speed limit from 80 km/hr to 70 km/hr would only reduce noise levels by an average of 2 dB at a distance of 100 m from the highway.

During the operational phase of the Project there will be bird mortality associated with collisions with automobiles. Roadkill is generally not considered as a significant source of mortality for bird populations (Leedy and Adams 1982). This is supported by a study which demonstrated that the survival rates of male Willow Warblers (*Phylloscopus trochilus*) were equal in areas near and far from highways (Reijnen and Foppen 1994). Roadkill data collected for a 100 Series Highway, secondary highway and city streets in Nova Scotia over a two year period yielded an average rate of roadkill of 0.9 birds/km/yr for the 100 Series Highway, 1.2 birds/km/yr for the secondary highway and 0.7 birds/km/yr for city streets (M. Crowell unpublished data). The new highway will be a 15 km long 100 Series Highway, therefore, the estimated number of birds killed in collisions with automobiles would be 13.5 per year. This is probably an underestimate of the actual number of birds likely to be killed since small birds are easily missed during the surveys and their bodies are quickly destroyed by traffic or removed by scavengers. If it is assumed that only one in ten birds killed by traffic is recorded, the estimated number of birds killed per year would be approximately 135 birds (M. Crowell unpublished data). This number represents only a small proportion of the local bird population.

Maintenance activities such as resurfacing and mowing of the RoW are not expected to have significant effects on local bird populations. Disturbance associated with repairs to the road surface are not expected to be any more intense than that encountered during the construction or operational phases of the project. Mowing of the RoW could destroy the nests of ground nesting birds such as the Bobolink which was found near the RoW at the West River and South River. The cleared RoW will be sown with a suitable seed mix (Table 2.2) and will produce a habitat suitable for this species to nest in particularly in areas where the RoW runs through existing hay fields or pastures. If feasible, the RoW (particularly in areas adjacent to existing agricultural land) will not be mowed until the end of July to avoid nest destruction.

5.6.6 Follow-Up and Monitoring

No follow-up studies or monitoring are proposed.

5.6.7 Summary of Residual Environmental Effects Assessment

Although Project construction and operation activities will potentially adversely affect birds through habitat loss and fragmentation, sensory disturbance, and in some cases, direct mortality, these effects are not likely to be significant with the implementation of the proposed mitigative measures. There is therefore not likely to be any significant adverse residual effects on rare or sensitive bird species. Tables 5.20 and 5.21 summarise the residual environmental effects evaluation for rare and sensitive birds.

Table 5.20 Residual Environmental Effects Assessment Matrix Rare and Sensitive Birds (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing, grubbing, blasting, excavation and sub-grade construction	• Sensory disturbance (A)	• Minimize the width of the cleared RoW • Schedule clearing to avoid breeding season of migratory breeding birds • Establish 200 m radius buffer zones around Osprey nests near route within which no construction activity is permitted	1	3	2 / 1	R	2	N	3
	• Habitat fragmentation and creation of edge habitat (A) • Loss of breeding habitat and nesting sites (A)	• Minimize the width of the cleared RoW • Clear RoW outside of breeding season (March to August) • Identify and mark minimum safe working area around bridge pier construction sites; approach roads to these sites should avoid habitat suitable for Nelson's Sharp-tailed Sparrow	1	3	5 / 6	R	2	N	3

KEY

Magnitude: 1 = Low: *i.e.*, specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: *i.e.*, portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: *i.e.*, affecting a whole stock, population or habitat, outside the range of natural variation

Geographic Extent: 1 = <500 m^2; 2 = 500 m^2 -1 km^2; 3 = 1-10 km^2; 4 = 11-100 km^2; 5 = 101-1000 km^2; 6 = >1000 km^2

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

Table 5.21 Residual Environmental Effects Assessment Matrix
Rare and Sensitive Birds (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Traffic	• Mortality associated with collisions (A)	• No mitigation recommended	1	3	5 / 6	R	2	N	3
	• Sensory disturbance (A)	• No mitigation recommended	1	3	5 / 6	R	2	N	3
RoW maintenance (*i.e.*, mowing)	• Destruction of nests of ground nesting species (A)	• Where feasible, do not mow cleared RoW between April 1 and August 1 to avoid destruction of the nests bird species such as Bobolinks which nest on the ground in grasslands	1	3	1 / 1	R	2	N	3

Refer to Table 5.20 for Key.

5.7 Rare Plants and Plant Communities

Rare plant species were selected as a VEC because they are rare elements of indigenous biodiversity and are often indicative of rare habitats that harbour unique assemblages of plants and animals. Preserving a rare plant species often ensures that rare habitats and their unique assemblages of species are preserved. Rare plant species are designated in the following ways:

- being listed as a species at risk at the national level by COSEWIC (COSEWIC 2004); and/or
- being listed as a rare species in Nova Scotia (ACCDC 2002a).

The VEC assessed in this section is the Nova Scotia population of any vascular plant species listed as rare in Nova Scotia or Canada.

Also included as part of this VEC are areas of rare or sensitive habitats. Rare or sensitive habitats develop in areas supporting unique combinations of soil, geology, topography, microclimate, and disturbance regimes. These would include habitats such as old growth forest, karst topography, cave systems, cliffs, rich intervales, alpine areas, and dune systems. These habitats often provide living areas for rare species of plants and animals and contribute to the overall habitat diversity of a particular area. The rarity of the habitat type can result in the concentration of plants or animals dependent on them into relatively small areas. By way of example, showy lady's-slipper (Cypripedium reginae) grows only in alkaline swamps and bogs. These habitats are rare in Nova Scotia, consequently, the distribution of showy lady's-slipper is restricted to a very small area of the province. Wetlands are specifically evaluated in Section 5.8 of this report. Plants of significance to Mi'kmaq are addressed in Section 6.3 and Appendix K.

5.7.1 Boundaries

The spatial boundary for the assessment of rare plants is the study area presented on Figure 1.1. Rare plants typically occur at specific places where the local habitat is suitable for their establishment and growth. Similarly, rare or sensitive habitats develop in areas having unique combinations of edaphic, geologic, topographic, and climatic conditions. Habitats with a relatively high likelihood of supporting rare species in the study area are wetlands and riparian habitats. These areas were most intensively investigated during the field surveys; however, all habitats with the exceptions of residential areas and active agricultural land were also surveyed. Field surveys were conducted from August 20 - 23, 2002. Temporal boundaries consider that rare plants or habitats are non-mobile and essentially present at a particular location on a continuous basis, therefore the opportunities for Project interaction are continuous during Project construction and operation.

5.7.2 Description of Existing Conditions

Information regarding plant species present in the study area was derived from a review of the existing literature, correspondence with staff of the Nova Scotia Department of Natural Resources (M. Pulsifer, pers. comm. 2002), the Nova Scotia Museum of Natural History (M. Munroe, pers. comm. 2002), the Atlantic Canada Conservation Data Centre (S. Gerriets, pers. comm. 2002) and through a field survey. The Atlas of Rare Vascular Plants of Nova Scotia (Pronych and Wilson 1993) was also reviewed to determine if any rare plant species had been recorded in the general area of the proposed highway. Eleven of the twenty-three records of rare and uncommon species for the study area are derived from this source. The information in the Atlas is mapped onto 10 x 10 km atlas squares and, as such, it is not possible to obtain precise locations for recorded specimens. A more precise location may be obtained for specimens that are part of the Nova Scotia Museum's holdings, since the closest community or named feature (*i.e.*, river, lake, mountain) to the location where the specimen was collected is provided. Although it is not possible to pinpoint the locations of rare plants using the Atlas, the data provided in it is useful for determining which rare vascular plants are most likely to be found in the study area, and which habitats should be most intensively searched. Information regarding the presence of rare vascular plants in the vicinity of the proposed South River crossing site were derived from botanical surveys conducted as part of the South River Impact Study (Appendix E. Table H.5 in Appendix H lists the 409 species of vascular plants found along the highway RoW during the field surveys.

Fourteen rare or uncommon vascular plants have been previously recorded in the general vicinity of the proposed highway (S. Gerriets, pers. comm. 2002). These include common alexanders (*Zizia aurea*), estuary beggar-ticks (*Bidens hyperborea*), daisy fleabane (*Erigeron hyssopifolius*), white snakeroot (*Eupatorium rugosum*), coffee-tinker's weed (*Triosteum aurantiacum*), button-bush dodder (*Cuscuta cephalanthi*), false mermaid-weed (*Floerkea proserpinacoides*), water pimpernel (*Samolus floribundus*), ebony sedge (*Carex eburnea*), Canada lily (*Lilium canadense*), large purple-fringed orchid (*Platanthera grandiflora*), blunt-leaf pondweed (*Potamogeton obtusifolius*), white-stem pondweed (*Potamogeton praelongus*), and bulblet fern (*Cystopteris bulbifera*). An additional nine uncommon species not previously documented in the Antigonish area were found on or near the proposed highway RoW during the field surveys. These included purple milkweed (*Asclepias incarnata*), black ash (*Fraxinus nigra*), hornwort (*Ceratophyllum demersum*), wood nettle (*Laportea canadensis*), bloodroot (*Sanguinaria canadensis*), water loosestrife (*Lysimachia thyrsiflora*), pennsylvania smartweed (*Polygonum pensylvanicum*), marsh mermaid-weed (*Proserpinaca palustris* var. *creba*) and readhead grass (*Potamogeton richardsonii*). The population status of each of these species is presented in Table 5.22.

Table 5.22	Population Status and Distribution of Uncommon and Rare Vascular PlantsFound in the Vicinity of Antigonish				
	Population Status			Distribution	
Species	Atlantic Canada Conservation Data Centre	Nova Scotia Department of Natural Resources	Flowering Period/Ease of Identification	Previously Recorded in Antigonish Area	Observed in or near Proposed RoW During Field Survey
Daisy fleabane	S2S3	Yellow	Flowers July and August. Easily identified when not in flower.	Yes	No
Ebony sedge	S3	Yellow	Late May to August. Peregynia required for identification.	Yes	No
Bulblet fern	S3S4	Green	Spores June to September. Can be readily identified by vegetative characteristics.	Yes	No
White-stem pondweed	S3	Undetermined	Flowers June and July. Rarely found fruiting. Can be identified without fruit.	Yes	No
Common alexanders	S1S2	Yellow	Flowers May and June. Fruit present into August. Can be identified using either flowers or fruit.	Yes	No
Estuary beggar-ticks	S1	Yellow	Flowers August and September. Flowers or fruit required for identification.	Yes	No
Water pimpernel	S2	Yellow	Flowers July to September. Can be identified without fruit but most easily identified with flowers present.	Yes	No
Button-bush dodder	S1	Undetermined	Flowers August and September. Flowers required for identification.	Yes	No
Canada Lily	S2S3	Yellow	Flowers in July. Readily identified vegetatively.	Yes	Yes
Coffee-tinker's weed	S2	Red	Flowers in July. Readily identified vegetatively.	Yes	Yes

Table 5.22 Population Status and Distribution of Uncommon and Rare Vascular PlantsFound in the Vicinity of Antigonish

Species	Population Status		Flowering Period/Ease of Identification	Distribution	
	Atlantic Canada Conservation Data Centre	Nova Scotia Department of Natural Resources		Previously Recorded in Antigonish Area	Observed in or near Proposed RoW During Field Survey
White snakeroot	S1	Undetermined	Flowers August and September. Can be identified by vegetative characteristics.	Yes	No
False mermaid-weed	S2S3	Yellow	Flowers late May to late June. A distinctive plant that can be identified without flowers.	Yes	No
Large purple-fringed orchid	S3	Green	Flowers in July. Flowers required for identification.	Yes	Yes
Purple milkweed	S3	Green	Flowers early August. Readily identified without flowers or seed pods.	No	Yes
Blunt-leaf pondweed	S2	Undetermined	Flowers July to September. Can be identified without fruit.	Yes	No
Black ash	S3	Yellow	Flowers May and June. Can be identified without samaras.	No	Yes
Hornwort	S3?	Undetermined	Flowers July to September. Can be identified without fruit.	No	Yes
Wood nettle	S3	Yellow	Flowers July to September. Readily identified without flowers or fruit.	No	Yes
Bloodroot	S3S4	Green	Flowers early May. Readily identified without flowers or fruit.	No	Yes
Water loosestrife	S3	Green	Flowers mid June to July. Can be identified without flowers but is considerably more easily identified with flowers or fruit present.	No	Yes
Pennsylvania smartweed	S3	Green	Flowers June to October. Flowers required for identification.	No	Yes

Table 5.22 Population Status and Distribution of Uncommon and Rare Vascular PlantsFound in the Vicinity of Antigonish

Species	Population Status			Distribution	
	Atlantic Canada Conservation Data Centre	Nova Scotia Department of Natural Resources	Flowering Period/Ease of Identification	Previously Recorded in Antigonish Area	Observed in or near Proposed RoW During Field Survey
Marsh mermaid-weed	S3S4	Green	Flowers July to September. Can be identified without fruit or flowers.	No	Yes
Redhead grass	S3?	Undetermined	Flowers July to September. Can be identified without fruit.	No	Yes

Atlantic Canada Conservation Data Centre Species Rank Definitions

S1	Extremely rare throughout its range in the province (typically 5 or fewer occurrences or very few remaining individuals). May be especially vulnerable to extirpation.
S2	Rare throughout its range in the province (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.
S3	Uncommon throughout its range in the province, or found only in a restricted range, even if abundant at some locations. (21 to 100 occurrences).
S4	Usually widespread, fairly common throughout its range in the province, and apparently secure with many occurrences, but the species is of long-term concern (e.g. watch list). (100 + occurrences).
S#S#	Numeric range rank: A range between two consecutive numeric ranks. Denotes uncertainty about the exact rarity of the species (e.g., S1S2)
S#?	Inexact or uncertain ranking.

Nova Scotia Department of Natural Resources General Status Ranks

Red	Known to be or thought to be at risk.
Yellow	Sensitive to human activities or natural events.
Green	Not believed to be sensitive or at risk.
Undetermined	Insufficient data exists to assess status

Source: ACCDC 2002a; NSDNR 2002a

While over half of the 23 species listed in Table 5.22 were observed in the area during the survey and over half had been previously recorded in the area, suitable habitat exits for most of these species in the general study area with the exception of daisy fleabane, ebony sedge, white-stem pondweed and bulblet fern. Daisy fleabane, ebony sedge and bulblet fern are typically associated with gypsum outcrops or calcareous (*i.e.*, containing calcium carbonate, calcium or limestone) soils which are not present in the study area. White-stem pondweed is usually found in the deep water of lakes. No lakes are present along the route.

Common alexanders are found in meadows, shores, damp thickets and wet woods. Habitats such as these are present along the proposed highway route. This species has been recorded along the South River above St. Andrews. Common alexanders were not encountered during the botanical surveys for this study or the South River Impact Study (Neill and Gunter Ltd. 2001).

Estuary beggar's-ticks, water pimpernel and button-bush dodder are all associated with seashores. The only area along the proposed highway route which could provide suitable habitat for these species is the proposed South River crossing site, which is located within the upper reaches of the South River Estuary. A botanical survey was conducted in this area as part of the environmental impact study for the proposed South River bridge and bridge approaches. None of these species were encountered during that survey.

White snakeroot is typically found in moist soils along the banks of watercourses as well as clearings, thickets and moist woods. All of these habitats were encountered along the proposed highway route; however, this species was not encountered during the botanical surveys.

False mermaid grows on the slopes of deciduous treed ravines, along watercourses, along the banks of rivers and in intervale forests. Habitat of this type is present at the West River and South River crossing sites. Botanical surveys conducted at these sites as well as elsewhere along the proposed highway route did not reveal the presence of this species.

Blunt-leaf pondweed is typically found in ponds, lakes and slow flowing streams. No lakes or ponds are present in the proposed RoW, however, there are several sluggish streams and streams which have been impounded by beaver activity which could provide suitable habitat. These areas were investigated during the botanical surveys but blunt-leaf pondweed was not found.

Canada lily, coffee-tinker's weed, wood nettle, and bloodroot are frequently associated with rich intervales and intervale forests. Along the proposed highway RoW this type of habitat is found only at the West River crossing site. All three species were found at this location (Figure 5.4). Two small patches of coffee-tinker's weed were found in an intervale thicket on the east bank of the river. The thicket was composed largely of speckled alder (*Alnus incana*), hawthorn (*Crataegus* sp.), apple (*Pyrus malus*), and white ash (*Fraxinus americana*). The ground vegetation understory was dominated largely by a mixture of dames rocket (*Hesperis matronalis*) and enchanter's nightshade (*Circaea lutetiana*). The thicket appears to have developed following abandonment of agricultural land that once extended to the edge of the river. The first patch of coffee-tinker's weed was located 23 m north of the flagged centerline. It consisted of 16 shoots which all appeared to be part of the same plant. This patch appears to be located at the northern edge of the footprint of the proposed bridge. The second patch was located 50 m north of the flagged centerline and contained two shoots which shared a common root system. This patch is located within the RoW of the highway but outside of the footprint of the proposed bridge. Coffee-tinker's weed is listed as rare by ACCDC and the Nova Scotia population is considered to be at risk by NSDNR.

A single patch of Canada lily containing three shoots was found 40 m south of the flagged centerline in the same habitat type as the coffee-tinker's weed. These plants are located at the southern edge of the footprint of the proposed bridge. The ACCDC rates Canada lily as rare to uncommon in Nova Scotia and NSDNR classes this species as sensitive to human activities or natural events.

Wood nettle was found on the banks of the river at the edge of the intervale thicket. Only two plants were found during the survey. Both were located within the footprint of the bridge structure. This species is considered to be uncommon by ACCDC and NSDNR indicates that the Nova Scotia population is sensitive.

Bloodroot was scattered throughout the intervale thicket although it was most frequently encountered along the edge of the thicket nearest the bank of the river. The population status of bloodroot is not well defined and varies from uncommon to fairly common (ACCDC). NSDNR considers the Nova Scotia population to be secure.

Large purple-fringed orchid was found in two wetlands found at 12 + 700 and 13 + 100 (Figure 5.4). Both wetlands were tall shrub dominated basin swamps. The swamp at 12 + 700 was dominated by speckled alder with a ground vegetation understory composed mainly of sensitive fern (*Onoclea sensibilis*) and fowl manna-grass (*Glyceria striata*). The large purple-fringed orchid at this wetland was located outside of the highway RoW. The swamp at 13 + 100 had a shrub layer dominated by a mixture of black alder (*Ilex verticillata*), speckled alder, false holly (*Nemopanthus mucronata*), and meadowsweet (*Spiraea alba*). The ground vegetation layer consisted mainly of sphagnum moss (*Sphagnum* spp.), sedge (*Carex trisperma*) and cinnamon fern (*Osmunda cinnamomea*). At this wetland, large purple-fringed orchid was found at the edge of the highway footprint. This species is listed as uncommon in Nova Scotia by ACCDC and NSDNR considers the Nova Scotia population to be secure.

Purple milkweed has not previously been found in the vicinity of Antigonish. During the botanical survey a large patch of purple milkweed containing approximately 500 shoots was found in a small wetland complex at 2 + 100 (Figure 5.4). The wetland complex consisted of a small basin marsh surrounded by a much larger tall shrub dominated basin swamp. The marsh plant community was composed largely of broad-leaved cat-tail (*Typha latifolia*), sensitive fern and marsh fern (*Thelypteris palustris*). The swamp was characterized by a dense speckled alder dominated shrub layer over a lush ground vegetation layer dominated by spotted touch-me-not (*Impatiens capensis*), cinnamon fern and sensitive fern. The purple milkweed at this site were located outside of the footprint of the highway but within the highway RoW. Purple milkweed is considered to be uncommon (ACCDC) and the population is considered secure (NSDNR).

Black ash was found in a recent clear-cut at 13 + 340 (Figure 5.4). One small black ash less than 20 years of age was found at this location. The tree was found near the edge of a small tall shrub dominated basin swamp and was within the footprint of the highway. Black ash is listed as uncommon in Nova Scotia (ACCDC) and the population is considered to be sensitive (NSDNR).

Hornwort and readhead grass were both found in the West River (Figure 5.4). Hornwort is often found growing in the backwaters of rivers with muck bottoms. It was found growing in a small backwater on the west bank of the river. The plants were outside of the footprint of the bridge but within the RoW. Redhead grass is typically found growing in lakes or rivers with brackish or alkaline waters. A large bed of readhead grass was found in the main channel of the West River within the RoW, downstream of the proposed bridge. The population status of both of these species are poorly understood. Both are tentatively classed as uncommon (ACCDC) and the sensitivity of the species has not been determined (NSDNR). Aquatic species such as hornwort and readhead grass are often overlooked in the field making it difficult to assess their population status.

Pennsylvania smartweed is found in a wide variety of habitat types including shores, roadsides, ditches, sandy beaches, grain fields, and dyked marshes. In the study area pennsylvania smartweed was found on the shores of the West River. The exact location where this species was found is not known since several species of *Polygonum* were collected at this site and in this habitat. Pennsylvania smartweed is an annual species; consequently, its distribution can vary substantially from year to year. This is especially the case on the shores of rivers where seeds are moved by water during high water events. Pennsylvania smartweed is considered to be uncommon (ACCDC) and the Nova Scotia population is listed as secure (NSDNR).

The habitat of marsh mermaid-weed includes boggy swales, savannas, wet marshes, and the edges of streams. It was found in two wetlands along the proposed highway. At the first site (0 + 650) marsh mermaid-weed was found in a stream marsh where it was one of the dominant species along with broad-leaved cat-tail, bulbous water-hemlock (*Cicuta bulbifera*) and marsh cinquefoil (*Potentilla palustris*). Many thousands of plants were present in the wetland. The distribution of marsh mermaid-weed was focussed largely at the western end of the wetland near the RoW for the proposed highway. About half of the area where this species was found is located within the RoW for the proposed highway; however, only about 10 % of the area is located within the footprint of the highway and would be disturbed by highway construction. The second location (5 + 250) was also in a stream marsh. This marsh was dominated by rush (*Juncus canadensis*), creeping bent-grass (*Agrostis stolonifera*), rice cut-grass (*Leersia oryzoides*), spike rush (*Eleocharis obtusa*), and bulrush (*Scirpus cyperinus*). Marsh mermaid-weed was much less common at this location and all of the plants were found outside of the highway RoW. The population status of marsh mermaid-weed is not well defined and varies from uncommon to fairly common (ACCDC). NSDNR considers the Nova Scotia population to be secure.

Water loosestrife is typically found in swamps, along brooks, or in shallow water and muck, at the edge of alkaline ponds and marshes. In the study area it was found at two locations in a stream marsh at 0 + 700 and 0 + 800. Both of these sites were located outside of the RoW for the proposed highway. Water loosestrife is considered by ACCDC to be uncommon and NSDNR considers the Nova Scotia population to be secure.

Two uncommon habitat types were identified along the proposed highway route during the field survey. These included rich intervale habitat on the floodplain of the West River (5 + 700) and brackish marsh and estuarine habitat located at the mouth of the South River (11 + 300).

Rich intervale habitat is uncommon in Nova Scotia for several reasons. First, the areal extent of fertile soils in Nova Scotia is quite low, limiting the areas where fertile flood plains can develop. Second, when *Europeans arrived in Nova Scotia,* these areas tended to be selectively developed as agricultural land since they were generally flat, fertile, close to reliable water sources, and often relatively free of stones. Consequently, relatively little undisturbed rich intervale habitat remains today. These areas are particularly valuable as habitats for a number of rare plant species which grow on fertile soils. Some uncommon or rare animals are also associated with intervale habitats. Wood turtles often forage in intervale habitat and the highest densities of wood turtles are typically found on rivers which have rich intervale habitat. Northern Orioles prefer to nest in elm trees and find suitable nesting habitat along rich intervales which are the primary habitat for this tree species. The incidence of Northern Oriole nesting in intervale habitat is probably much reduced now as a result of the loss of most wild mature elms to Dutch elm disease. They now tend to nest most frequently in towns where elms have been protected from this disease.

The rich intervale at the West River crossing site has been substantially degraded by past land use practices. It appears that the intervale was cleared and used as pasture. It was later abandoned and was colonized by tree and shrub species. The intervale thicket is characterized by a relatively dense cover of hawthorn, choke cherry, speckled alder and white ash. The ground vegetation understory is now composed mainly of dame's rocket and enchanter's nightshade. Dame's rocket is an introduced ornamental species which appears to be able to persist under the dense shrub canopy. This species may exclude native plant species from the site. The banks of the river, which in undisturbed intervales provide habitat for a variety of rare native species have, in the case of the West River intervale, been heavily colonized by a variety of introduced weed species including dames's rocket, nipplewort (*Lapsana communis*), common burdock (*Arctium minus*), couch grass (*Elymus repens*), wild cucumber (*Echynocystis lobata*), and live-forever (*Sedum telephinum*).

In spite of the past disturbance of this site it still supports a number of rare and uncommon plant species. These include coffee-tinker's weed, Canada lily, wood nettle, and bloodroot. Several other uncommon species have been recorded in the river or on exposed river bed during low water periods. These include readhead grass, hornwort and pennsylvania smartweed. One uncommon bird species, Black-billed Cuckoo was heard singing in shrub thickets adjacent to the West River. Dead elms along the intervale are used as perching sites by Bald Eagles and Osprey which feed on various fish species which utilize the West River as a migration route.

The second uncommon habitat type found along the route is the coastal freshwater marsh found at the mouth of the South River. Coastal freshwater marshes are highly productive wetlands which develop in areas where freshwater inputs moderate the effects of tidal flooding allowing wetland plant species intolerant of saline conditions to survive (Simmons *et al.* 1984). These wetlands are nutrient rich and highly productive. The vegetation is dominated by a variety of gramminoid including grasses, sedges, and rushes which are tolerant of periodic flooding. Coastal freshwater marshes provide important habitat for a variety of birds and mammals including waterfowl, muskrat, raccoon, and mink. The marsh at the proposed South River crossing site provides feeding and possibly breeding habitat for American Black Duck and American Wigeon. Other species of waterfowl can be expected to use this habitat. Waders such as Great Blue Heron feed in the wetland and Osprey and Bald Eagle forage along the portion of South River which flows through the wetland. The wetland also provides breeding habitat for Nelson's Sharp-tailed Sparrow an uncommon bird species which is considered to be sensitive to human activities (primarily loss of marsh habitat). This habitat has been described and assessed in the South River Impact Study (Neill and Gunter Ltd. 2001) (refer to Appendix E).

5.7.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect occurs when the population of a species is sufficiently affected to cause a decline in abundance and/or change in distribution beyond which natural recruitment would not return the population to its former level within several growing seasons.

A **positive** effect occurs when project activities help to increase species populations and/or diversity.

5.7.4 Potential Issues, Interactions and Concerns

Twelve uncommon or rare species were found during the field survey, within or in close proximity to the RoW for the proposed highway. These include coffee-tinker's weed, Canada lily, wood nettle, black ash, bloodroot, pennsylvania smartweed, hornwort, readhead grass, purple milkweed, water loosestrife, marsh mermaid-weed, and large purple-fringed orchid. Construction and operation of the highway could adversely affect these species in several ways. During the construction phase of the project, species found within the RoW of the highway could be lost as a result of clearing and grubbing operations. Species found in wetland habitats off the RoW could potentially be adversely affected if the hydrology of the wetland habitats are changed resulting in flooding or drainage of the wetland.

Rare or uncommon vascular plant species could also be adversely affected during the operational phase of the Project. Local populations could be affected by vegetation control programs and application of deicing salt. Rare species located immediately adjacent to bridge structures could be affected by the shade cast by the structure.

Two sensitive habitat types are found along the route, including rich intervale habitat at the West River crossing site and coastal freshwater marsh at the proposed South River crossing site. Construction activities could result in the direct loss of these habitats. At the West River site there are seven rare or uncommon vascular plant species which could be directly affected by habitat loss. Construction activity could also indirectly affect the ability of these habitats to support rare or sensitive species. The South River site provides habitat for a variety of sensitive bird species which may be frightened from the habitat by construction activity.

5.7.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.7.5.1 Construction

Rare or uncommon plant species are most likely to be adversely affected by the Project during the construction phase. A total of twelve rare or uncommon species of vascular plant were found on or near the highway RoW during the field surveys. These species vary in their provincial abundance and in their vulnerability to changes in the environment. In addition, a number of the species encountered during the botanical surveys are located outside of the highway RoW and may not be directly affected by construction and operation of the highway. Table 5.23 lists the uncommon and rare species found on or near the highway route in descending order of sensitivity to the highway Project.

Table 5.23 Uncommon and Rare Vascular Plant Species found in or near the Proposed Highway RoW in Descending Order of Sensitivity to the Project

Common Name	Population Status		Potential for Interaction with Proposed Highway
	Atlantic Canada Conservation Data Centre	Nova Scotia Department of Natural Resources	
Coffee-tinker's weed	Rare	At risk	High
Canada lily	Rare to uncommon	Sensitive	High
Wood nettle	Uncommon	Sensitive	High
Black ash	Uncommon	Sensitive	High
Bloodroot	Uncommon	Secure	High
Pennsylvania smartweed	Uncommon	Secure	High
Large purple-fringed orchid	Uncommon	Secure	High
Purple milkweed	Uncommon	Secure	Moderate
Hornwort	Uncommon	Secure	Moderate
Water loosestrife	Uncommon	Secure	Low
Redhead grass	Uncommon	Secure	Low
Marsh mermaid-weed	Uncommon to fairly common	Secure	High

Coffee-tinker's Weed

The species of primary concern is coffee-tinker's weed which is listed as rare and is considered to be at risk. Two patches of coffee-tinker's weed were found, one located at the edge of the proposed West River bridge footprint, the other located in the RoW north of the bridge. Given the close proximity of the first patch to the bridge there is potential for it to be disturbed. The second patch appears to be far enough from the bridge that it could be easily protected from disturbance. Coffee-tinker's weed appears to grow well in areas that have been lightly to moderately disturbed. A large population of coffee-tinker's weed found along the East River of Pictou was growing on a power transmission RoW which had been cleared, grubbed and subjected to regular brush clearing operations. Approximately 90 % of the population was found on the transmission line while 10 % was found in adjacent woodlands.

The preferred approach to minimizing the effect of bridge construction on coffee-tinker's weed would be to shift the location of the bridge crossing approximately 125 m to the north to avoid the two coffee-tinker's weed populations as well as other rare or uncommon species found during the field survey. However, a repositioning of the crossing site is not feasible due to the other constraints (*e.g.*, cemetery, residences and wetland) that would be affected by this shift.

The effect of bridge construction on coffee-tinker's weed will depend largely on the design of the bridge. If the bridge abutments are placed on the banks of the river and the approaches to the bridge are constructed by infilling the intervale habitat on the east side of the river, the population of coffee-tinker's weed closest to the bridge will be lost. The second population might also be lost depending on where the toe of the slope of the infilled portion of the bridge approach road is located. If the bridge abutments are located at the base of the slopes on either side of the river and the intervale habitat is left intact it would be possible to save both populations. Construction activity would have to be closely monitored to ensure that the rich intervale habitat found under and adjacent to the bridge is disturbed as little as possible. Particular care would need to be taken during the placement of the bridge piers.

In addition to altering the bridge design to minimize impacts on coffee-tinker's weed, a habitat enhancement program will be implemented to increase the abundance of coffee-tinker's weed and other rare or uncommon species at this site. The habitat enhancement program would be conducted within the RoW at the West River crossing site. Where possible, NSTPW will consider purchasing intervale land immediately north and south of the RoW which would be restored and protected. The program would consist of planting rare species including coffee-tinker's weed to increase the local population and restoration of the rich intervale plant community. Coffee-tinker's weed seed would be harvested from local areas where coffee-tinker's weed populations are well established such as the population found on the Nova Scotia Power RoW at the East River of Pictou. If seed is plentiful, the harvested seed would be planted in suitable habitat in the RoW and any additional suitable intervale lands purchased by NSTPW. If seed is scarce it may be necessary to germinate the seed and plant the seedlings in order to increase the probability of establishing more coffee-tinker's weed.

Habitat restoration would consist mainly of reducing the abundance of non-native species in the intervale, primarily dame's rocket, which is very abundant in the understory of the intervale thicket. This could be accomplished through mechanical removal of the plants or by painting the leaves of target species with a herbicide. Habitat restoration would also involve the establishment of tree and shrub species characteristic of undisturbed intervales in the area.

Ideally the habitat enhancement program will be underway prior to construction of the bridge. This way, additional coffee-tinker's weed plants established near the edge of the RoW or outside of the RoW would provide a back-up population in case the population at the edge of the bridge was accidentally lost during construction.

Canada Lily

Canada lily is also found at the West River crossing site. A patch of three Canada lily shoots was found at the southern edge of the bridge. Construction activity could result in the disturbance of this species given its close proximity to the bridge. The bridge construction options and habitat enhancement program described for coffee-tinker's weed could also be used to preserve and enhance the population of Canada lily. Canada lily is easily propagated by seed although it may take four to five years to grow a mature plant.

Wood Nettle

Two wood nettle shoots were found under the proposed bridge site on the east bank of the West River. Construction activity is likely to result in the loss of this species if it is necessary to grub or move heavy equipment near the east bank of the river. Establishment of bridge abutments and piers away from the banks of the river would help to preserve this population. The habitat enhancement program would also be directed at increasing the abundance of this species on the intervale.

Black Ash

A single black ash was found in a recent clear-cut near the centerline of the highway. Clearing and grubbing prior to highway construction would result in the loss of this tree. The preferred mitigation for this species would be to shift the RoW 100 m south to avoid the black ash however, this shift could place the large purple-fringed orchid at 12 + 700 at risk and would have a greater impact on an adjacent trailer park. The Nova Scotia population of large purple-fringed orchid is considered secure while the black ash population is sensitive. Since this alignment modification is not feasible, NSTPW proposes to plant black ash seedlings to replace the black ash lost to highway construction. Ideally black ash derived from a local seed source will be planted. The plantings will be made as close to the location of the original black ash as possible and in the same habitat type.

Bloodroot

Bloodroot was found scattered through the intervale thicket at the West River crossing site. Many of the plants were found within the footprint of the bridge. The number of plants lost to construction activity can be reduced by adopting a bridge design which minimizes the degree of disturbance to the habitats within the footprint of the structure. A tall bridge with abutments established at the toe of the slope rather than on the intervale would reduce the number of bloodroot lost to disturbance. Losses of bloodroot caused by construction disturbance could be recouped by propagating bloodroot as part of the habitat enhancement program. Bloodroot is readily cultivated from seed and root cuttings.

Pennsylvania Smartweed

Pennsylvania smartweed was found growing on the gravel shores of the West River at the bridge crossing site. This species could be adversely affected by construction activity if the shore of the river is disturbed by vehicles. Given the value of the West River as fish habitat it is likely that disturbance of the river banks will be avoided in which case loss of pennsylvania smartweed is unlikely. Pennsylvania smartweed is an annual species, consequently, the population may be present in the RoW in some years but not in others.

Large Purple-fringed Orchid

Large purple-fringed orchid is present at two locations along the route. Both sites are in tall shrub-dominated swamps. At the first site large purple-fringed orchid is found outside of the highway RoW and will not be directly affected by construction activity. It could be indirectly affected by construction if the road structure or construction activity alters the hydrology of the wetland. This wetland drains away from the highway so it is unlikely that ponding would occur. Mitigation to protect large purple-fringed orchid at this location would consist of designing the road drainage system to ensure that the hydrology of the wetland is not altered substantially. At the second site large purple-fringed orchid is found within the footprint of the highway and is likely to be lost as a result of construction activity. Given the secure status of this species no mitigation is proposed at this site.

Purple Milkweed

Purple milkweed is also found in a wetland (Figure 5.4). Approximately 500 purple milkweed shoots were found outside of the footprint of a proposed off-ramp but within the highway RoW. Clearing and grubbing of the RoW could result in the loss of this population. The adverse effects of construction activity can be reduced substantially by minimizing disturbance to the wetland habitat in which purple milkweed is found. The portion of the wetland outside of the footprint of the off-ramp will not be cleared or grubbed.

Hornwort

Hornwort is found in a muddy backwater on the west bank of the West River. This backwater is located outside of the footprint of the proposed bridge but inside the RoW. This population could be impacted by construction activities if equipment were run through the backwater or if the morphology of the river channel was changed as a result of bridge construction. If the bridge is designed such that the abutments or piers do not fall within or immediately adjacent to this backwater there should be little effect on this species. In addition, erosion and sedimentation control measures will be implemented to ensure that sediment is not deposited in the backwater. Given the value of the West River as fish habitat, it is likely that disturbance of the river banks will be avoided and erosion and sedimentation controls will be implemented reducing the potential for disturbance of the backwater in which hornwort is located.

Water Loosestrife

Water loosestrife is found at two locations in a wetland situated on Brierly Brook. Both sites are located outside of the highway RoW so no direct adverse effects of construction are anticipated. This species could be indirectly affected by construction activity if the hydrology of the wetland is altered by construction activity. The highway will infill a small portion of the wetland at its outflow so there is potential for ponding or drainage of the wetland if culverts are not positioned properly. In order to prevent any adverse effects on this species care will be taken in culvert placement to prevent any alteration in wetland hydrology.

Redhead Grass

Redhead grass was found in deep water in West River just downstream of the proposed bridge. It is unlikely that bridge construction will occur in the river at this location so direct loss of this population is not expected. Deposition of large quantities of silt could smother the plants, however, this is unlikely since the current at this location is swift and erosion and sedimentation control measures will be used to minimize erosion.

Marsh Mermaid-weed

Marsh mermaid-weed is located in two wetlands along the proposed highway route. The first site is in the Brierly Brook wetland (Wetland 1). Marsh mermaid-weed is very abundant in the marsh habitat at the western end of the wetland. Infilling of the wetland to add an additional lane to the existing highway will result in the loss of a small proportion of this population. This infilling could also adversely affect the population by causing ponding or draining of the wetland if culverts are not positioned properly. The second population is located on another wetland located near the West River. This population was located outside of the highway RoW, however, the wetland is located upstream of the highway so there is some potential for ponding if drainage conditions are altered. Mitigation to minimize adverse effects to these populations would include ensuring that existing hydrological conditions are maintained through proper sizing and placement of culverts. Given the small proportion of the Brierly Brook wetland population lost as a result of infilling and the secure status of this species, the only mitigation proposed to minimize the number of plants lost to disturbance is to infill only enough of the wetland to provide a safe roadbed. No clearing will occur in wetland habitat found within the new highway RoW but outside of the highway footprint.

Uncommon Habitat Types

Construction of the bridge over the West River will result in the loss and/or disturbance of part of the rich intervale thicket found on the floodplain of the river. The main effect of this habitat loss would be the potential loss of several small populations of rare and uncommon vascular plant species as well as a reduction in the amount of habitat suitable for plant species which are largely restricted to rich intervale habitat. The bridge design options and habitat enhancement program described above to minimize the effect of the Project on rare and uncommon plant species would also be applicable to this uncommon habitat type.

The coastal freshwater marsh located at the mouth of the South River will also be adversely affected by bridge construction. Relatively little habitat is expected to be lost at this location. The main effect would be disturbance of wildlife which use this habitat type for breeding and foraging. Potential mitigative measures to minimize adverse effects on this habitat type discussed in the South River Impact Study (Neill and Gunter Ltd. 2001) included: avoidance of infilling flood plain to maintain flood storage capacity and to minimize displacement of terrestrial habitat; alignment of the structure to minimize the area of terrestrial habitat under the structure; and location of the new structure in proximity to the existing structure to minimize the total area affected by noise and vibration.

No significant adverse residual effects to rare plants and plant communities are anticipated. The primary species of concern during the construction period are the Canada lily, coffee-tinker's weed, wood nettle, and the black ash which can be restored through a habitat enhancement program and replanting. Impacts to other plant communities may also be mitigated through the habitat enhancement program as well as through minimization, where appropriate, of disturbance to vegetation.

5.7.5.2 Operation and Maintenance

Vegetation control operations could pose a hazard to rare plant species found within the RoW of the highway. It is unlikely that coffee-tinker's weed, Canada lily, wood nettle, pennsylvania smartweed or bloodroot would be affected by these operations since they are situated beside the West River bridge. Nevertheless, the locations of these populations on the RoW will be noted and regular mowing or brush clearing will not be conducted in the intervale in which these species are located. Vegetation management programs designed to enhance these populations would be permitted provided they are managed by personnel knowledgeable of the habitat requirements of these species. Hornwort, redhead grass and marsh mermaid-weed would not be affected by vegetation management operations since they are aquatic plants found at locations where herbicide applications are not permitted and where mechanical brush control is not required. The black ash tree found on the RoW will be lost as a result of highway construction and will be replaced by saplings planted outside of the RoW. Similarly, one of the two large purple-fringed orchids found along the highway route will be lost during the construction phase, however, the second orchid is located outside of the RoW and will not be affected. The water loosestrife at Brierly Brook is also located outside of the RoW and will not be affected by vegetation control operations. The purple milkweed population could be adversely affected by vegetation control operations. This population is located within the RoW at an off-ramp. In order to protect this population, no mowing or brush cutting will be permitted within the wetland habitat in which the population is located. The population is located immediately adjacent to a small stream where herbicide applications would not be made.

Road salt applications can damage plants located immediately adjacent to highways and increase the salinity of soils. The effects of road salt are generally observed within 10 m of the edge of the road, although salt related injuries have been detected at distances of up to 80 m from the road. Damage to vegetation includes osmotic (*i.e.*, concentration induced dehydration) injuries as well as direct chloride ion toxicity. Salt deposited on soils can adversely affect plant growth by changing the structure of soil (development of salt crusts) or reducing soil fertility (replacement of calcium and potassium ions by sodium ions). In some areas between 5 and 10 % of trees within 30 m of highways had salt damage (Transportation Research Board 1991).

Road salt applications could potentially affect five of the rare and uncommon species found growing within the RoW of the highway including coffee-tinker's weed, Canada lily, wood nettle, bloodroot and purple milkweed. The first four of these species were found at the West River crossing site while purple milkweed is found at the proposed Addington Forks off-ramp. Bridge design can be used to minimize the effects of road salt on the species found at the West River site. Drainage of salt laden runoff from the immediate approaches and structure will be directed away from areas where rare or uncommon plants are present. Measures will be taken to minimize the amount of brine and brine contaminated slush and snow that are thrown over the side of the bridge by snow plows and other vehicles; for example snow and slush that accumulate on the bridge will be plowed off the bridge rather than over the side. This may require that snow plows reduce speed when plowing the bridge. Techniques which reduce the amount of road salt used will be employed. These include the use of road weather information systems to monitor road surface conditions, pre-wetting of salt and the use of zero velocity spreaders to prevent salt from bouncing off the road and the use of anti-icing systems such as brine solutions to minimize the amount of salt required. These techniques would benefit other VECs in addition to the rare plants found along the proposed highway including groundwater and surface water quality and freshwater aquatic life. This section would be considered as a salt sensitive area to be considered for pre-wetting and anti-icing agents. NSTPW has prepared a Salt Management Strategy for this Project (Appendix L) that will be implemented to minimize adverse environmental effects related to road salt.

The mitigative measures used to protect rare and uncommon plant species at the West River crossing site would also protect the rich intervale habitat at this site. Mitigative measures to protect the coastal freshwater marsh habitat at the South River proposed in the South River Impact Study (Neill and Gunter Ltd. 2001) include a spanning structure to minimize displacement of aquatic habitat and maintenance the hydrologic function (*i.e.*, flood storage) of the area (refer to Appendix E).

The primary impacts of highway operation on rare plants and plant communities result from the use of road salts for deicing during the winter. Provided that the proposed mitigative measures are employed, no significant adverse effects are anticipated from highway operations.

5.7.6 Follow-Up and Monitoring

The most sensitive site for rare plants along the proposed highway route is at the West River crossing site. As part of the mitigation plan to minimize the effects of bridge construction and operation on the species found at this location, an intervale habitat enhancement program is proposed. The populations of rare and uncommon plant species found at this site would be monitored as part of this program. This data would be used to assess the effects of the construction of the bridge and the efficacy of the habitat enhancement program.

5.7.7 Summary of Residual Environmental Effects Assessment

No significant Project-related adverse residual effects on rare plants or habitats are anticipated if mitigative measures are employed. Tables 5.24 and 5.25 summarise the residual environmental effects evaluation for rare plants and plant communities.

Table 5.24 Residual Environmental Effects Assessment Matrix
Rare Plants and Plant Communities (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing, Grubbing and Sub-grade construction	• Mortality of existing plants (A)	Black Ash • Plant black ash seedlings to replace the ash sapling lost to highway construction; • Replacement trees will be monitored for at least four years before onset of construction Purple Milkweed • Avoid clearing portion of Wetland 2 that is located within the RoW but outside of the footprint of the highway Water Loosestrife • Carefully place and size culverts to ensure that the hydrology of the Brierly Brook Wetland (Wetland 1) is not altered Marsh Mermaid-weed • At Brierly Brook wetland (1) minimize wetland infilling • Carefully place and size culverts to ensure that the hydrology of the Brierly Brook Wetland (Wetland 1) is not altered	2	3	1 / 1	R	2	N	2

Table 5.24 Residual Environmental Effects Assessment Matrix Rare Plants and Plant Communities (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Bridge Construction (West River)	• Mortality of existing plants (A)	Coffee-tinker's Weed, Canada Lily, Wood Nettle, Bloodroot • Design the bridge structure to minimize the amount of intervale habitat disturbed by the bridge • Plan the bridge pier construction sites to minimize the amount of habitat disturbed • Implement an intervale enhancement program to improve habitat quality and increase populations of sensitive species	2	1	2 / 1	R	2	N	2
Bridge Construction (West River)	• Loss and disturbance of rich intervale habitat (A)	Rich Intervale Habitat at West River • Design the bridge structure to minimize the amount of intervale habitat disturbed by the bridge • Plan the bridge pier construction sites to minimize the amount of habitat disturbed • Implement an intervale enhancement program to improve habitat quality and increase populations of sensitive species	2	1	2 / 1	R	2	N	2

KEY

Magnitude: 1 = Low: i.e., specific group or habitat, localized, one generation or less, within natural variation; 2 = Medium: i.e., portion of a population or habitat, 1 or 2 generations, rapid and unpredictable change, temporarily outside range of natural variability; 3 = High: i.e., affecting a whole stock, population or habitat, outside the range of natural variation

Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects.

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

Table 5.25 Residual Environmental Effects Assessment Matrix
Rare Plants and Plant Communities (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
RoW Vegetation Maintenance	• Mortality of existing plants (A)	Purple Milkweed • Avoid mowing or brush cutting wetland habitat at Wetland 2 that is located within the RoW	2	1	1 / 1	R	2	N	2
De-icing	• Mortality of existing plants, degradation of habitat (A)	Coffee-tinker's Weed, Canada Lily, Wood Nettle, and Bloodroot: • Direct bridge drainage away from areas where rare or uncommon species are present • Minimize brine and brine contaminated slush and snow thrown over the side of the bridge by snow plows and other vehicles • Identify the West River section where these species occur as a salt sensitive area to be a candidate for pre-wetting and anti-icing agents to reduce exposure to salt laden runoff	2	1	1 / 2	R	2	N	2

Refer to Table 5.24 for Key.

5.8 Wetlands

Wetlands are considered a VEC because they are an important feature of the landscape, performing many biological, hydrological, social/cultural, and economic production functions which are of value to society. Wetlands provide habitat for plant and animal species, many of which depend on wetland habitats for their survival. Hydrological functions of wetlands include erosion and flood control, contaminant reduction, and groundwater recharge and discharge areas. Wetlands support various forms of recreational activity, as well as subsistence production, such as harvesting of wildlife and plants, and commercial production, such as cranberry bogs, forestry, and peat extraction. Related VECs include: Section 5.4 Rare Herpetiles, 5.5 Rare Mammals and Critical Habitat, Section 5.6 Rare and Sensitive Birds, and 5.7 Rare Plants and Plant Communities

5.8.1 Boundaries

The spatial boundaries for assessment of wetlands is the study area indicated on Figure 1.1. Since wetlands are a semi-permanent landscape feature and may interact with the Project year-round, temporal boundaries consider Project effects on a year-round basis, during construction and operation activities. Other temporal considerations include sensitive times for some species such as bird breeding periods.

5.8.2 Description of Existing Conditions

In Nova Scotia, wetlands are protected by the NSDOE (currently NSDEL) Wetlands Directive (1995a). Any loss of wetland requires a wetland evaluation to establish the value of the wetland in relation to the merits of the development. Wetland evaluations are required if a project will physically disturb a wetland or if the hydrology of the wetland will be altered by construction or operation of the project. Wetlands less than 2 ha in size can be evaluated using a ten-step evaluation process used by NSDEL. Wetlands greater than 2 ha in size are evaluated using the North American Wetlands Conservation Council (Canada) wetland evaluation technique.

Twenty-one wetlands are located within the RoW of the proposed highway, nineteen of which were evaluated during the field survey conducted from August 20 - 23rd, 2002. The remaining two wetlands were not evaluated during this survey because one of the wetlands, Wetland 5, an anthropogenic (man made) pond, had been infilled prior to the evaluations, while the other, Wetland 21 at South River, had been previously evaluated as a component of the South River Impact Study (Neil & Gunter Ltd. 2001). The location of the wetlands are mapped on Figure 5.4, while the findings of the wetland evaluations are summarized in Table 5.26, with complete evaluations presented in Appendix I for the wetlands evaluated in 2002, and in Appendix E for the South River wetland evaluation.

Table 5.26 Wetlands Found Within the Proposed Highway 104 RoW

Wetland No.	Type	Size (ha)	*Area Likely to be Infilled by Highway Development (ha)	Wetland Evaluation Process	Results of Evaluation
1	Wetland complex composed of low shrub stream swamp, tall shrub stream swamp, mixedwood treed stream swamp, and stream marsh	11.23	0.35	North American Wetlands Conservation Council	Wetland provides moderate level of surface water flow regulation and habitat for two uncommon plant species. Construction of highway will not significantly alter these functions provided care is taken not to alter wetland hydrology.
2	Wetland complex composed of tall shrub basin swamp and shallow basin marsh	0.42	0.08	NSDEL 10 step	Wetland provides habitat for an uncommon plant species. Area of wetland in which this species is found will not be affected by highway construction.
3	Coniferous treed basin swamp	0.95	0.12	NSDEL 10 step	Not significant
4	Tall shrub basin swamp	0.71	0.27	NSDEL 10 step	Not significant
5	Shallow water wetland (fire pond)	N/A	N/A	No evaluation, wetland infilled	N/A
6	Wetland complex composed of tall shrub basin swamp, deciduous treed basin swamp and shallow basin marsh	4.27	0.81	North American Wetlands Conservation Council	Wetland provides moderate level of surface water flow regulation and water quality treatment. Construction of the highway is not expected to significantly alter these functions provided care is taken not to alter the hydrology of the wetland and steps are taken to minimize the amount of wetland habitat affected.
7	Tall shrub basin swamp	0.23	0.21	NSDEL 10 step	Not significant
8	Wetland complex composed of tall shrub basin swamp and shallow basin marsh	0.42	0.21	NSDEL 10 step	Not significant
9	Tall shrub basin swamp	0.31	0.25	NSDEL 10 step	Not significant
10	Wetland complex composed of tall shrub stream swamp, stream marsh and shallow water wetland	0.5	0	NSDEL 10 step	Wetland provides habitat for an uncommon plant species as well as breeding habitat for amphibians. The wetland may also play a small role in surface water regulation. Wetland will not be disturbed and no adverse effects on wetland function will occur provided wetland hydrology is not affected.
11	Wetland complex composed of tall shrub stream swamp, low shrub stream swamp and shallow water wetland	2.93	0.01	North American Wetlands Conservation Council	Wetland provides moderate level of surface water flow regulation. This function will not be significantly affected by highway construction.

Table 5.26 Wetlands Found Within the Proposed Highway 104 RoW

Wetland No.	Type	Size (ha)	*Area Likely to be Infilled by Highway Development (ha)	Wetland Evaluation Process	Results of Evaluation
12	Tall shrub stream swamp	7.28	0.75	North American Wetlands Conservation Council	Wetland provides moderate level of surface water flow regulation. This function will not be significantly affected by highway construction.
13	Wetland complex composed of mixedwood treed basin swamp and tall shrub basin swamp	0.94	< 0.01	NSDEL 10 step	Not significant
14	Tall shrub basin swamp	0.23	0.14	NSDEL 10 step	Not significant
15	Tall shrub stream swamp	0.57	0.03	NSDEL 10 step	Wetland provides habitat for an uncommon plant species. The area where this species is found will not be affected by highway construction provided care is taken not to alter the hydrology of the wetland.
16	Coniferous treed basin swamp	0.8	0.29	NSDEL 10 step	Not significant
17	Tall shrub basin swamp	0.71	0.05	NSDEL 10 step	The wetland provides habitat for an uncommon species which will be lost as a result of highway construction. The population is small (one plant) and the population is considered secure in Nova Scotia, so this loss is considered acceptable.
18	Mixedwood treed basin swamp	1.13	0.43	NSDEL 10 step	Not significant
19	Wetland complex composed of mixedwood treed basin swamp and tall shrub basin swamp	0.54	0	NSDEL 10 step	Wetland probably provides a water quality treatment function since it receives water from roadside ditches on the existing Highway 104. This function will not be significantly affected by highway construction.
20	Mixedwood treed basin swamp	0.99	0.99	NSDEL 10 step	Not significant
21	Coastal Freshwater Marsh	15.8	0.5 (approximated using Map 1 (Neill and Gunter Ltd. 2001))	North American Wetlands Conservation Council	The wetland contains significant habitat for migratory birds. The area provides good feeding and staging habitat for waterfowl and is an important foraging area for local Osprey and Bald Eagles. Several Bald Eagle nests are located adjacent to the wetland. Nelson's Sharp-tailed Sparrow, listed as sensitive (NSDNR 2002a), probably breeds in the wetland. The South River estuary provides valuable habitat for a variety of fish species. Some flood and tidal impact protection is provided by the wetland. This function will not be significantly affected by highway construction.

* Note: Area to be infilled calculated using a map overlay and the area of the lane width and median.

During the route selection process for this Project, NSTPW identified wetlands as one of several constraints to be considered for avoidance. Wetland Golet scores were used during the screening process to help identify the most significant wetlands for avoidance for preliminary routing.

Specific examples of wetland avoidance during routing include:

- Sta 4+000 alignment kept as far away from wetland to the north. Alignment confined by existing development to the south.
- Sta 8+000 to 9+500 alignment kept as far north from wetlands to the south. Alignment confined by development to the north.
- Sta 13+000 to Sta 14+000 alignment is fixed on both ends due to recommended corossing of South River to the west and the existing Highway 104 to the east. Distance from developments to the south had to be considered, along with curvature design of the roadway.

In recognition of the South River crossing, a specific impact study was conducted, prior to the final route selection and EA Registration to determine the most ideal crossing location, particularly from an environmental perspective. The resulting route is the most desirable route based on environmental, socioeconomic and engineering constraints. As such, the remaining wetlands identified in the EA report cannot be avoided by the RoW. NSTPW will, in consultation with NSDNR and NSDEL, develop a wetland compensation plan to help mitigate the loss of wetland habitat as a result of this Project.

Two types of wetland are found within the proposed RoW of the highway: swamp and marsh. All wetlands found in the study area had a swamp element associated with them and in all instances, the swamp element was the largest element of wetland complexes where more than one type of wetland was present. Swamps are mineral wetlands or peatlands with standing water or water flowing slowly through pools or channels. The water table is generally at or near the surface of the swamp. There is internal water movement from the margin of the swamp or from other sources of mineral enriched waters. If peat is present, it consists mainly of well-decomposed wood, underlain at times by sedge peat. The vegetation typically consists of a dense cover of trees or shrubs, herbs and some mosses.

All of the swamps present in the RoW are classed as either basin swamps or stream swamps (National Wetlands Working Group 1987). Basin swamps occur in topographically defined basins where the water is derived locally but may be augmented by drainage from other parts of the watershed. Stream swamps occur on the banks of permanent or semi-permanent streams. The high water table is maintained by the level of water in the stream. The swamp is seasonally flooded, with subsequent sediment deposition. Swamps in the study area can be further subdivided based on the dominant vegetation.

Four types of basin swamp are present including: mixedwood treed basin swamp; coniferous treed basin swamp; deciduous treed basin swamp; and tall shrub basin swamp. Mixedwood treed basin swamps in the study area are characterized by a tree canopy dominated by red maple (*Acer rubrum*), balsam fir (*Abies balsamea*) and black spruce (*Picea mariana*). The shrub understory of this wetland type is typically composed largely of speckled alder (*Alnus incana*), winterberry *(Ilex veticata)* and false holly *(Nemopanthus mucronata)*. Coniferous treed basin swamps in the study area typically have a tree layer composed largely of black spruce, tamarack (*Larix laricina*) and red maple. The shrub understory is similar in species composition to mixedwood treed basin swamp. Deciduous treed basin swamps are characterized by a tree canopy composed almost entirely of red maple and a shrub layer dominated by a mixture of speckled alder, red maple saplings, meadowsweet (*Spiraea alba*), and winterberry. Tall shrub basin swamps typically have a diffuse tree canopy composed largely of white spruce (*Picea glauca*), red maple, tamarack, and black spruce under which is a moderately dense shrub layer dominated by speckled alder, winterberry, meadowsweet, and trailing blackberry (*Rubus hispidus*).

Three types of stream swamp are present along the proposed RoW including mixedwood treed stream swamp, tall shrub stream swamp, and low shrub stream swamp. Mixedwood treed stream swamp is characterized by an open tree canopy composed of a mixture of black spruce and red maple. The shrub understory is moderately dense and is composed mainly of speckled alder, meadowsweet and advanced regeneration of red maple. Tall shrub stream swamp is similar in species composition to tall shrub basin swamp. Low shrub stream swamp is typically found in very wet areas and often forms a transition zone between marsh habitats and tall shrub swamp. The shrub layer is typically dominated by meadowsweet and/or sweet gale (*Myrica gale*). Stunted speckled alder are often mixed in with these species.

Marshes are mineral wetlands or peatlands that are periodically inundated by standing or slow flowing water. Surface water levels generally fluctuate seasonally. During drier periods declining water levels may expose areas of matted vegetation or mud flats. The surface waters are typically rich in nutrients. The substrate is usually mineral material although well-decomposed peat may occasionally be present. Marshes typically display zones or surface patterns consisting of pools or channels interspersed with patches of emergent vegetation, bordering wet meadows and peripheral bands of shrubs or trees.

Coastal freshwater marsh, shallow basin marsh and stream marsh are the only marsh types present in the study area. Coastal freshwater marsh is found only at the proposed South River crossing site. This wetland is described in the South River Impact Study (Appendix E). Shallow basin marshes occupy uniformly shallow depressions or swales, having a gradual gradient from the edge to the deepest portion. The marsh edge may be poorly defined due to rapidly receding water levels. Shallow basin marshes in the study area are highly variable in regards to plant species composition. Dominant species associated with these wetlands include broad-leaved cat-tail *Typha latifolia*), blue-joint (*Calamagrostis canadensis*), dulichium *Dulichium arundinacea*), and sensitive fern (*Onoclea sensibilis*). Stream marshes occupy the margins of streams. Water level in stream marshes is regulated by fluctuations in stream water level. The plant species composition in stream marshes in the study area is also highly variable. Dominant species include broad-leaved cat-tail, marsh mermaid-weed (*Proserpinaca palustris*), rush (*Juncus canadensis*), and creeping bent-grass (*Agrostis stolonifera*). Both marsh types support a sparse shrub layer composed largely of either speckled alder or meadowsweet.

The wetland evaluations indicated that five of the wetlands (Wetlands 1, 2, 10, 15, and 17) provide habitat for uncommon plant species including water loosestrife (*Lysimachia thyrsiflora*) (Wetland 1), marsh mermaid-weed (Wetland 1 and 10), purple milkweed (*Asclepias incarnata*) (Wetland 2), and large purple-fringed orchid (*Platanthera grandiflora*) (Wetlands 15 and 17). All of these species are listed as uncommon in Nova Scotia by the ACCDC (2002a). NSDNR (2002a) considers the Nova Scotia populations of these species to be secure. No species considered to be rare or endangered or sensitive to anthropogenic activities were found in any of the wetlands found within the RoW of the proposed highway.

The four largest wetlands (Wetlands 1, 6, 11, and 12) are believed to play a moderate role on surface water flow regulation. These wetlands can be expected to augment stream flow during dry periods resulting in more even stream flow by slowly releasing waters stored in the wetland. These wetlands will also help to reduce flooding by acting as a reservoir for flood waters and by slowing the flow of flood waters.

Five of the wetlands found within the proposed highway (Wetlands 1, 2, 6, 7, and 19) RoW may currently contribute to improved water quality. All of the wetlands with the exception of Wetland 7 are located at the edges of roads. Surface water draining from these roads into the wetlands could be contaminated with sediment, metals, hydrocarbons, and road salt. Wetlands are quite efficient at removing sediment and metals from surface water but are poor at retaining hydrocarbons, sodium and chloride ions. Wetland 7 receives drainage from a hay field and may be exposed to surface water containing sediment, nutrients and pesticides.

5.8.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect occurs when there is a net loss of wetland functions in a wetland of significant value as determined through a recognized wetland evaluation system.

A **positive** effect may enhance the quality, increase the species diversity, or increase the area of the wetland.

5.8.4 Potential Issues, Interactions and Concerns

Construction activities could affect wetlands along the alignment in several ways. The movement of heavy machinery across wetlands and infilling associated with wetland crossings could result in physical disturbance of plant communities and substrates. Other activities such as clearing, grubbing and grading of terrestrial habitats at the edges of wetlands could result in sedimentation of wetlands. Runoff from exposed acid generating slates could adversely affect wetlands as a result of elevated acidity, the mobilization of metals, and smothering of wetland plant communities as a result of deposition of iron floc at groundwater discharge sites in wetlands exposed to acidic drainage. However, this is not considered likely to occur given the geology present in the study area (refer to Section 2.4.12). Infilling of wetlands can alter the hydrologic regime due to interference with or diversion of groundwater or surface water flows in the wetland. Roadbeds constructed adjacent to wetlands can also alter wetland hydrology if improper culvert placement impedes proper drainage resulting in flooding of the wetland. Wetlands not crossed by the RoW could be affected by noise during construction and operations if the wetland supports species that are particularly sensitive to anthropogenic disturbance.

5.8.5 Analysis, Mitigation and Residual Environmental Effects Prediction

5.8.5.1 Construction

Twenty-one wetlands are located within the proposed RoW. One of these wetlands, Wetland 5, was infilled prior to the onset of the field survey so a wetland evaluation could not be completed at this location. Another wetland, Wetland 21, was described and evaluated as part of the South River Impact Study. The wetland description and results of the wetland evaluation for this location are provided in Appendix E. Synopses of the results of the South River wetland study are provided in Tables 5.26 and 5.27. The effects of the Project on the remaining 19 wetlands are discussed in the following text. Construction will result in heavy infilling (50 % or more of wetland infilled) of five wetlands (Wetlands 7, 8, 9, 14 and 20), moderate infilling (25 to 50% of wetland infilled) of three wetlands (Wetlands 4, 16 and 18) and light infilling (less than 25% of wetland infilled) of nine wetlands (Wetlands 1, 2, 3, 6, 11, 12, 13, 15, and 17). Wetlands 10 and 19 will not be infilled. Wetlands not crossed by the highway could be adversely affected as a result of alteration of wetland hydrology caused by construction activities or by inputs of sediment.

Wetlands 4, 7, 8, 9, 14, 16, 18, and 20

These wetlands are classed as not significant and will be moderately to heavily disturbed by construction activity. Unfortunately, it is not feasible to avoid these wetlands as a result of other environmental, safety, socio-economic or engineering constraints. NSTPW will, in consultation with NSDNR and NSDEL, develop a wetland compensation plan to help mitigate the loss of wetland habitat as a result of this Project. It may be possible to mitigate the loss of wetland habitat through the construction of replacement wetland habitat in the vicinity of the infilled wetland. Replacement wetland, if required, would consist of wetland habitat capable of replacing or exceeding the wetland functions lost or reduced in the original wetland. The most important function of these wetlands is surface water flow regulation, a function that can be replaced using constructed wetlands or by restoring the partially infilled wetlands. These wetlands would be established along the same drainage courses as the original wetlands in order to maintain this wetland function. The use of replacement habitat to mitigate wetland habitat loss is far less desirable than avoidance of habitat loss since it can be very difficult to duplicate the structure and functions of many wetland types.

Regardless of the type of compensation employed, it is important to maintain existing drainage conditions to prevent unintentional alterations of wetland habitat.

The implementation of mitigative measures to minimize sedimentation and accidental discharges of harmful substances would reduce the potential for these wetlands to be adversely affected by construction activity. Mitigative measures to reduce erosion and sedimentation would include:

- keeping ground disturbance in and adjacent to streams and wetlands to a minimum, and restricted to within the RoW;
- stabilization and/or revegetation of disturbed areas immediately after construction;
- the use of drainage control structures designed to prevent erosion;
- isolation of stockpiled soil from adjacent wetlands and streams; and
- direction of surface runoff as overland flow through shallow vegetated channels or into retention/sedimentation basins equipped with debris traps and baffle arrangements.

Wetland 1, 6, 11, and 12

These wetlands were identified as having valuable hydrologic functions. In particular, they are large enough to help augment stream flow during low flow periods. They may also help to alleviate flood conditions by storing flood waters and releasing them slowly. The amount of wetland habitat lost as a result of highway construction in the four largest wetlands (1, 6, 11 and 12), ranges from 0.5 to 19.0% of the wetland area and averages 8.2 %. The loss of this wetland area is not expected to have a significant adverse effect on the hydrological functions of the wetlands (H. Arisz, pers. comm. 2002).

It is not feasible to avoid these wetlands given the presence of other environmental, safety, socio-economic, or engineering constraints along the route. However, the wetland compensation plan may consider replacing the hydrologic functions of the wetland through creation of wetland habitat along the margins of the damaged wetlands. The amount of wetland habitat created would be equal to or greater than the size of the wetland habitat lost. In instances where it is not possible to add replacement habitat to the existing wetland, a new wetland could be established along the same drainage course as the damaged wetland. Where possible, construction of the highway through a particular wetland will be conducted concurrently with the creation of replacement wetland habitat. This would allow the recovery and reuse of the organic matter layer of the wetland. This material would provide a suitable substrate for wetland species to colonize the replacement wetland habitat and would provide a seed bank as well as other propagules that could be used to rapidly establish a cover of native wetland plant species.

These wetlands could also be adversely affected if construction of the highway adversely affects the hydrology of the wetland. To prevent this, care will be taken in the design of the drainage system for the highway to maintain the existing drainage patterns. In addition, mitigative measures to minimize sedimentation of the wetland and to prevent accidental releases of materials such as fuel and lubricants as described for Wetlands 4, 7, 8, 9, 14, 16, 18, and 20 will be implemented to ensure that biological activity outside of the RoW is not adversely affected.

Wetlands 1, 2, 10, 15, and 17

These wetlands support uncommon plant species and will be partially infilled as a result of highway construction. The amount of infilling ranges from 0 to 19 %. In all but two of the wetlands (Wetlands 1 and 17) the uncommon species will not be directly affected by construction activity. Wetland 1 contains two uncommon species, marsh mermaid weed and water loosestrife. Wetland 17 supports a small population (one plant) of large purple-fringed orchid. About half of the populations of marsh mermaid-weed and water loosestrife in the area are located within the highway RoW. It is unlikely that the portion of the RoW which falls within Wetland 1 (other than the portion required for the roadbed of the eastbound lane) will be cleared and grubbed since vegetation cover is low and the surface of the wetland will not support heavy equipment. It is likely that only the portion of the wetland under the footprint of the eastbound lane will be disturbed. This would result in the loss of about 10 % of the area occupied by marsh mermaid-weed and no loss of any water loosestrife. The large purple-fringed orchid found in Wetland 17 is located within the footprint of the highway and will be lost during construction. The Nova Scotia population of large purple-fringed orchid is considered secure and only one plant was found at this site. Given the difficulty in shifting the RoW, the loss of large purple-fringed orchid at this location is considered acceptable. There is some potential for indirect effects as a result of alteration of wetland hydrology or vegetation maintenance during the operational phase of the project, however, these factors can be controlled by means of mitigative measures.

The areas of these wetlands disturbed by highway construction will be minimized by clearing, grubbing and infilling only the areas required for the roadbed. The portions of these wetlands found in the RoW but outside of the footprint of the highway will be left undisturbed. Other than avoidance and minimization of habitat disturbance, no other mitigation is proposed for the remaining wetlands in regards to the plant habitat function for two reasons. First, the populations of uncommon plant species found in these wetlands will not be directly affected by construction activities. Second, the habitat requirements of these species are poorly understood so that creation of new habitat for these species would have a high probability of failure. More generic mitigation such as the creation of replacement habitat as described for Wetlands 1, 6, 11, and 12 would help to offset the general loss of wetland habitat but would probably not provide suitable habitat for the uncommon species found at these sites.

At Wetland 17 it may not be possible to avoid the large purple-fringed orchid. Given the status of this species as secure in Nova Scotia, the small number of plants affected and its presence at another location nearby, the loss of this population would probably be acceptable. NSDNR and the Nova Scotia Museum would be consulted prior to any activity at this location to ensure that loss of this population is acceptable. Mitigative measures to reduce erosion and sedimentation of streams and wetland habitats will be employed along with measures to avoid alteration of the hydrology of the wetlands will be employed to reduce the potential of any indirect adverse effects on these species.

Wetlands 1, 2, 6, 7 and 19

The field surveys suggested that these wetlands may receive contaminated surface water and may help to improve surface water quality. Wetlands 1, 2 and 19 receive surface water from the existing Highway 104 which may have elevated levels of suspended solids, metals, hydrocarbons, sodium and chloride. Wetland 6 also receives roadside drainage; however, it is also found adjacent to an urban area and may also receive surface water inputs which have elevated concentrations of nutrients such as nitrogen and phosphorus. Wetland 7 receives drainage from a hay field which may contain elevated concentrations of suspended solids, nutrients and pesticides. Wetlands are effective at filtering, absorbing or adsorbing sediment, metals, nutrients, and organic chemicals such as pesticides. They are not very effective at removing sodium and chloride ions or hydrocarbons.

Wetlands 1, 2 and 6 will be partially infilled as a result of highway construction; however, no infilling is expected to occur in Wetland 19. No wetland habitat will be lost in Wetland 19 and relatively little habitat will be lost at Wetlands 1 (3.1%), 2 (19%) and 6 (19%). Road construction at these sites is not expected to result in a significant reduction in the ability of these wetlands to remove contaminants. Wetland 7 will be almost completely infilled (88.9%); consequently, this wetland function will be eliminated at this site. The highway RoW will replace the hay field and Wetland 7 will no longer receive agricultural drainage.

Since avoidance of these wetlands is not feasible due to other constraints, NSTPW will, in consultation with NSDNR and NSDEL, develop a wetland compensation plan to help mitigate the loss of wetland habitat as a result of this Projet. If wetland compensation involves replacing wetland habitat it is recommended that wetland habitat be constructed to maintain the existing water quality function of the last wetland habitat. At Wetlands 1, 2 and 6 replacement wetland habitat could be constructed along the margins of the existing wetlands. At Wetland 7 a new wetland would need to be constructed. The creation of replacement habitats or complete wetlands could be undertaken at the same time that construction is scheduled to occur in the wetlands so that the substrate of the wetland can be salvaged and used in the replacement wetland habitat. This substrate harbours the microbial communities which aid in the breakdown or sequestration of toxic compounds. The organic materials in the substrate are also effective at adsorbing contaminants. Prior to salvaging the substrate at these wetlands, it would be tested to ensure that there is no risk of releasing harmful concentrations of contaminants immobilized therein when the substrate is disturbed. These wetlands could be adversely affected by sedimentation, hydrological changes or accidental events. The mitigative measures for erosion and sediment control, hydrology and accidental events will be applied to these wetlands.

The concerns with respect to wetlands is the hydrological function they provide as well as the habitat they may offer certain species. The primary mitigative measure for wetlands is avoidance where feasible, or alternatively reconstruction, within the same drainage course, of affected wetlands, to restore habitat and hydrologic function. Implementation of sediment and erosion control measures during construction also aids in minimizing potential alteration of wetland hydrology. Habitat issues are further discussed in antecedent sections (5.4, 5.5, 5.6 and 5.7) where applicable. Specific concerns have been raised by DFO regarding infilling of Wetland 6 and impacts on Brierly Brook. The hydrologic behaviour of wetland 6 controlled by the existing culvert under Highway 104 (*i.e.*, the invert of this culvert and the approach channel controls the upstream water levels, while the discharge capacity of the culvert is believed to control the peak flows from the wetland). Although the infilling of the wetlands will reduce the footprint of the wetlands in this area, the hydraulic control of the existing culvert combined with the gently rolling topography of the watershed upstream of this culvert are expected to ensure that the impacts of the proposed highway construction on the local and regional baseflow hydrology in Brierly Brook will be negligible.

Provided that the proposed mitigative measures are applied, no significant adverse effects to wetlands are anticipated during construction.

5.8.5.2 Operation and Maintenance

Operation of the proposed highway may affect wetlands in the study area in several ways. Traffic on the highway may disturb wildlife which use wetland habitats. None of the wildlife species encountered in the wetlands are considered to be particularly sensitive to human activities. Bird abundance can be expected to be lower in habitats immediately adjacent to the road as a result of disturbance. This effect is localized and is not expected to have significant adverse effects on regional populations (See Section 5.6). Wildlife populations in wetlands may also be affected by collisions with automobiles. Studies have shown that survival rates among bird populations adjacent to roads are generally not significantly lower than in populations located away from roads (Leedy and Adams 1982; Reijnen and Foppen 1994). The incidence of roadkill can be reduced by establishing wildlife corridors which can be used by wildlife to avoid crossing busy highways. Watercourse crossings are good locations to establish wildlife corridors. Wildlife often use riparian habitats as travel routes and the presence of watercourses requires that provisions be made to allow water to cross the RoW. Bridges and culverts used to convey water can be modified or larger structures installed to provide passages for wildlife. One relatively large wetland (Wetland 11) is present on one of the larger streams (Stream Crossing No. 11) crossed by the highway. The northern end of this wetland will be crossed by the highway. The presence of traffic on the highway could impede the movement of wildlife.

An arch-structure (open bottom culvert) is being considered for this location, and this would facilitate wildlife movement.

Four of the wetlands found along the proposed highway route are also located along the edge of the existing Highway 104. There was no noticeable zonation of plant communities in these wetlands associated with proximity to the highway which might indicate that plant species composition had been altered by exposure to road salt. Although no obvious road salt-related environmental effects were noticed, subtle changes in species composition could be present. Given that functional wetland habitats are present at these four locations in spite of exposure to road salt, the potential effect of road salt applications on the remaining wetlands is not expected to be significantly adverse.

The primary concern regarding wetlands with respect to highway operation is the potential effects of road salts on plant communities found within wetlands in the study area. Another concern relates to potential mortality or disturbance of plant species found within the wetlands. No significant adverse effects are anticipated during highway operation from the use of road salts on the highway, particularly with the implementation of NSTPW's Salt Management Strategy (Appendix L). The use of wildlife corridors where feasible will lower impacts to wildlife to insignificant levels.

5.8.6 Follow-Up and Monitoring

NSTPW will, in consultation with NSDNR and NSDEL, develop a wetland compensation plan to help mitigate the loss of wetland habitat as a result of this Project. If wetland habitat is constructed to replace wetland habitat lost during construction, a monitoring program will be established. After a suitable growing period (the length of which will be dependent on the type of wetland constructed), a wetland functional analysis will be conducted to determine if the constructed wetland(s) has developed the functional attributes deemed necessary to compensate for the loss of functional attributes in the original wetland.

5.8.7 Summary of Residual Environmental Effects Assessment

Provided the proposed mitigative measures are implemented, there is not likely to be any significant residual adverse environmental effects on wetlands as a result of the Project. Tables 5.27 and 5.28 summarise the residual environmental effects evaluation for wetlands.

Table 5.27 Residual Environmental Effects Assessment Matrix Wetlands (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing, grubbing, blasting, excavation and sub-grade construction	Wetlands in General • Habitat loss/alteration (A) • Increased erosion leading to sedimentation (A) • Alteration of hydrologic regime (A) • Loss of wetland functional attributes (A)	Wetlands (General) • Avoid wetland habitat wherever feasible • Where avoidance is not feasible, construct replacement wetland habitat capable of replacing loss of wetland functions • Implement erosion control measures • Design the highway and associated drainage system to avoid altering wetland hydrology	2	2	2 / 6	I	2	N	2
	Wetlands 1, 6, 11 and 12 • Loss of hydrologic function (surface water retention and flood control) (A)	Wetlands 1, 6, 11 and 12 • Salvage wetland soils from disturbed wetland habitat and incorporate into replacement wetland habitat to speed establishment of plant communities	2	2	2 / 6	R	2	N	2
Clearing, grubbing, blasting, excavation and sub-grade construction	Wetlands 1, 2, 6, 7 and 19 • Loss of water quality function	Wetlands 1, 2, 6, 7 and 19 • Salvage wetland soils from disturbed wetland habitat and incorporate into replacement wetland habitat to speed establishment of plant communities • Test salvaged soil to ensure that toxic concentrations of contaminants will not be released when the soil is moved	2	3	2 / 6	R	2	N	2

Table 5.27 Residual Environmental Effects Assessment Matrix Wetlands (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing, grubbing, blasting, excavation and sub-grade construction	Wetlands 1, 2, 10, 15, and 17 • Presence of uncommon plant species	Wetlands 1,2,10, 15, and 17 • Minimize the amount of wetland habitat affected by clearing, grubbing and infilling only the portion of the wetland required for construction of the road bed	2	3	2 / 6	I	2	N	2
	Wetland 21 • Habitat loss/alteration (A) • Loss of hydrologic function (Protection from tidal flooding) (A) • Loss of recreational opportunities (interruption of spring sports fishing and wildlife viewing opportunities) • Loss of Sharp-tailed Sparrow breeding habitat (sensitive species) (A) • Disturbance of breeding Sharp-tailed Sparrows (A) • Sedimentation of wetland and estuarine habitat (A)	Wetland 21 • Design bridge structure to minimize the amount of habitat affected • Minimize infilling of flood plain to maintain flood storage function and minimize loss of terrestrial habitat • Align the bridge structure perpendicular to the river and at the narrowest point • Locate the bridge as close as possible to the existing structure to minimize the disturbance of wildlife.	2	1	2 / 6	R	2	N	2

Table 5.27 Residual Environmental Effects Assessment Matrix Wetlands (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		

KEY

Magnitude: 1 = Low: i.e , specific area of wetland localized, within natural variation; no change to wetland functions; 2 = Medium: i.e., major portions of wetland; changes to wetland functions temporarily outside range of natural variability; 3 = High: i.e., affecting entire wetland, net loss of wetland functions

Geographic Extent: 1 = <500 m^2; 2 = 500 m^2 -1 km^2; 3 = 1-10 km^2; 4 = 11-100 km^2; 5 = 101-1000 km^2; 6 = >1000 km^2

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

Table 5.28 Residual Environmental Effects Assessment Matrix Wetlands (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Traffic	• Mortality of wetland wildlife associated with vehicle interactions (A)	• Consider construction of wildlife corridors at watercourse crossing sites (at Wetland 11) to reduce the incidence of roadkill	1	3	5 / 6	R	2	N	2
	• Sensory disturbance to wildlife (A)	• No mitigation recommended	1	3	5 / 6	R	2	N	2
De-icing	• Increased salinity to wetland (A)	• No mitigation recommended	1	3	5 / 6	R	2	N	2

Refer to Table 5.27 for Key.

5.9 Species at Risk

Species at risk are identified within their respective VEC sections (Section 5.4 Rare Herpetiles, Section 5.5 Rare Mammals and Critical Habitat, Section 5.6 Rare and Sensitive Birds, and Section 5.7 Rare Plants and Plant Communities). This section of the report takes a closer look at federal species at risk in context of the SARA.

5.9.1 *Species at Risk Act (SARA)*

One of Canada's strategies to protect biological diversity is to address species at risk. These are native species that are sensitive to human activity due to their rare occurrence, restricted range in Canada, dependence on specialized habitats or declining population or distribution (Canadian Wildlife Service 2004). This has been achieved through, amongst other initiatives, the Species at Risk Act (SARA). SARA serves to protect listed species by prohibiting activities that may harm individuals or critical habitat. Specific prohibitions under SARA came into force on June 1, 2004; those relevant to the proposed Project, include the following:

- Section 32 (1): No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species.
- Section 33: No person shall damage or destroy the residence of one or more individuals of a wildlife species that is listed as an endangered species or a threatened species, or that is listed as an extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada.
- Section 58: Subject to this section of the Act, no person shall destroy any part of the critical habitat of any listed endangered species or of any listed threatened species - or of any listed extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada - if (a) the critical habitat is on federal land, in the exclusive economic zone of Canada or on the continental shelf of Canada; (b) the listed species is an aquatic species; or (c) the listed species is a species of migratory birds protected by the Migratory Birds Convention Act, 1994.

SARA has been linked to the Canadian Environmental Assessment Act (CEAA) through requirements in both Acts. Section 79 of SARA requires that the RA must notify the competent minister (likely DFO or Environment Canada) in writing if a project being assessed is likely to affect a listed wildlife species or its critical habitat. The RA must identify the adverse effects of the project on the species/critical habitat and, if the project is carried out, must ensure that measures are taken to avoid or lessen the effects and to monitor them. The measures must be taken in a way that is consistent with any applicable recovery strategy and action plan. CEAA specifically includes within its definition of "environmental effect" any change a project may cause to a listed wildlife species (i.e., listed under SARA), its critical habitat (i.e., the habitat that is necessary for the survival or recovery of a listed species and that is identified in the recovery strategy or action plan for the species) or the residences of individuals of that species (i.e., a dwelling place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating).

5.9.2 Assessment of Species at Risk for the Project

No listed wildlife species were observed within the study area during the field surveys. However, two listed species have been reported to occur in the general area of Antigonish.

The Piping Plover melodus subspecies (Charadrius melodus melodus) is listed as an endangered species (COSEWIC 2004) on Schedule 1 of the SARA. Its presence has been identified within a 10 km x 10 km census square indicated in the Atlas of Breeding Birds of the Maritime Provinces database (breeding bird atlas) (Erskine 1992). However, as indicated in the National Recovery Plan for the Piping Plover (Goossen et al. 2002), nesting and feeding habitat for this species includes sandy beaches, tidal flats, shores of coastal lagoons, ponds and salt marshes, sand and mud flats and algal flats. These habitats are not present within the study area, therefore there is no predicted interaction between the Project and this species.

The other listed species is the wood turtle (Glyptemys insculpta), which is listed as a species of special concern on Schedule 3 of SARA. Although the wood turtle was not observed during field surveys, this species is known to be associated with the West and South Rivers and suitable foraging and cover habitat for this species was found at the West River crossing site. This species was last assessed by COSEWIC in 1996 and therefore must be reassessed against revised criteria before it can be considered for addition to Schedule 1 of SARA. Specific prohibitions such as those listed above do therefore not apply to this species. Furthermore, critical habitat and recovery strategies have not yet been defined for this species. Specific mitigation, including a wood turtle risk management program as described in Section 5.4.6 will be implemented by TPW in consultation with NSDNR to minimize Project-related adverse effects on the local wood turtle population.

6.0 SOCIOECONOMIC EFFECTS ASSESSMENT

6.1 Local Economy

Local economy is considered a VSC due to its importance to the community of Antigonish and quality of life for its residents. In particular, there is a concern among businesses that the customer-base will decline due to reduction in through-traffic to commercial establishments along the existing Highway 104. This could cause a decline in business revenues and business tax income. The local economy could also be affected by increased spending associated with highway construction as well as opportunities for opening new areas for commercial, residential and industrial developments as a result of improved access.

The scope of assessment of this VSC includes potential economic effects on: income and employment; commercial establishments; agriculture; fishery industry; forestry; and recreation and tourism. A related VSC, Land Use, is discussed in Section 6.2.

6.1.1 Boundaries

The spatial boundary of the assessment covers both the Town and County of Antigonish. In 1996, Louis Berger (Canada) Limited, commissioned by the Antigonish Chamber of Commerce, conducted an Economic Impact Study (Louis Berger (Canada) Ltd. 1996) which examined the economic impacts of various highway alignment options on the local economy. Although the alternative alignments that were considered in that report are slightly different from the current proposed alignment, basic information in the study remains relevant. The Berger study divided the study area into six zones for the purpose of their analysis:

Zone 1	From Pictou County Line to the Brierly Brook/Addington Forks Exit
Zone 2	From the end of Zone 1 to James Street intersection
Zone 3	From the end of Zone 2 to Beech Hill Road intersection
Zone 4	From the end of Zone 3 to Taylor Road intersection
Zone 5	From the end of Zone 4 to East Tracadie/Monastery intersection
Zone 6	From the end of Zone 5 to Guysborough County Line

Zone 6 and most of Zone 5 is excluded from the current Project study area. For the purposes of this assessment, the study area is divided into the following zones:

Zone 1	From 0+000 to 1+900 (Addington Forks Road on the existing highway)
Zone 2	From 1+900 to 3+800 (intersection of the existing highway and James Street)
Zone 3	From 3+800 to 6+500 (Beech Hill Road exit)
Zone 4	From 6+500 to 14+827 (eastern point of the proposed RoW)

The spatial assessment boundary includes an area (distance to the north and south from the existing alignment) within which majority of economic impacts occur (Louis Berger (Canada) Ltd. 1996). A rural area with low population (*i.e.*, Zones 1 and 4) would have a confined impact width limited to approximately 100 to 150 m on either side of the roadway, while for more densely populated areas with arterial roads connecting to the existing Highway 104, the impact width extends farther. For the purpose of this study, the boundary in Zone 2 will be 250 m and in Zone 3 will be 500 m on either side of the highway. However the study boundaries will extend to the entire economy of Antigonish (both Town and County) when appropriate. Figure 6.1 presents the boundaries from Zone 1 to end of Zone 4.

Temporal boundaries of Project impacts on local economy include construction and operation phases. Construction is estimated to occur over a four year period, while the operation phase will be continuous. Other temporal issues related to the local economy include seasonal businesses (*e.g.*, tourist-related) and activities (*e.g.*, recreation).

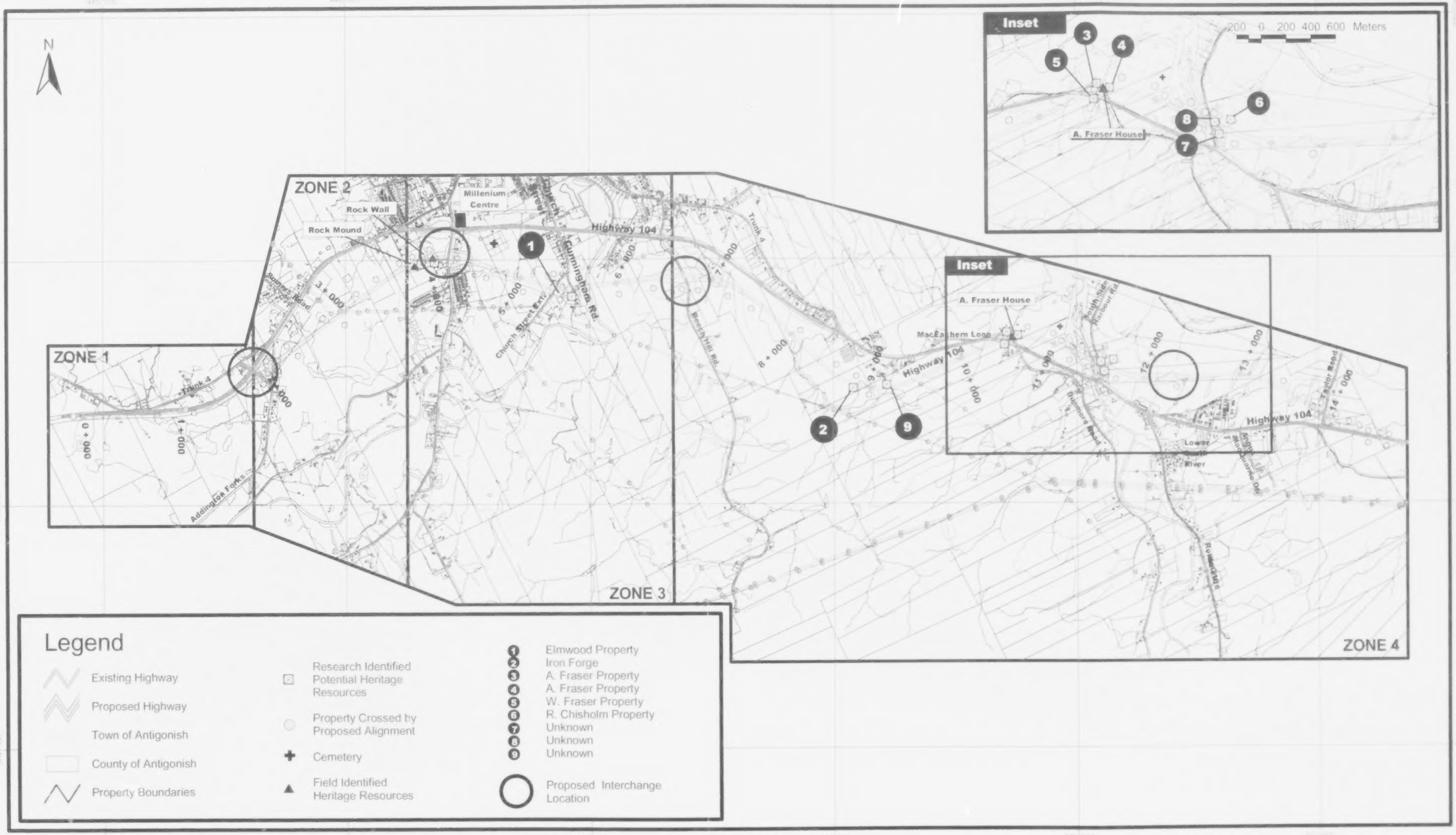
6.1.2 Description of Existing Conditions

6.1.2.1 Commercial Establishments

An inventory of commercial establishments in the Berger study was updated through site inspection. There are no commercial establishments within Zone 1. Zone 2 has several commercial establishments located on both the north and south sides of the existing Highway 104. This section is locally referred to as Post Road. The establishments are summarised in Table 6.1.

Table 6.1 Establishments Along The Existing Highway 104, Zone 2 Antigonish

Establishment	Type
South Side Locations	
Housekeeping Units	Small Business
Lobster Treat	Restaurant
Chrysler Dodge	Auto Dealership
Truck Dealership	Auto Dealership
Zincko's Transfer Co.	Transportation/Light Manufacturing
Super Value Mall	Retail
Ultramar Gas	Gas Station
Equipment Supplies	Small Business
Private Homes (2)	Homes (2)
North Side Locations	
Fashion Frenzies	Retail
Vacuum Village	Small Business
Esso Gas	Gas Station
Metro Gas	Gas Station
Rental Business	Small Business
Century 21	Small Business
NS Transportation Building	Government Building
Irving Gas	Gas Station
Private Homes (4)	Homes (4)



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Jacques Whitford

NOVA SCOTIA
Transportation and Public Works

SCALE: 1 : 37 500
Date: 9/01/2004
Drawn By: GM
Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

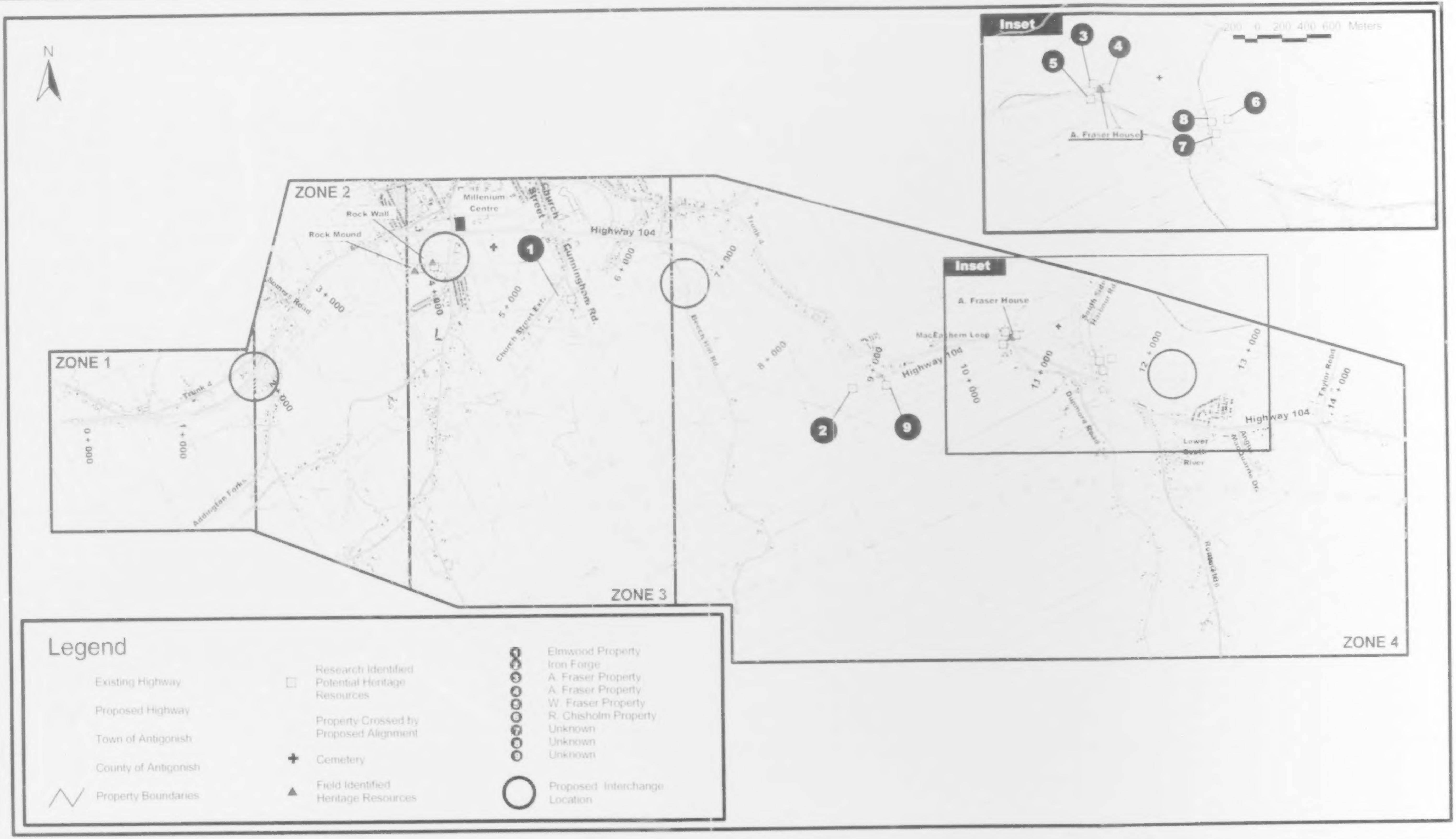
ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Socio-Economic Features

.5 0 .5 1.0 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.
NSD16949
FIGURE 6.1



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ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Socio-Economic Features

.5 0 .5 1.0 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.
NSD16949
FIGURE 6.1

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Zone 3 covers the commercial stretch on the northern section of the existing Highway 104 and mostly within the boundary of the Town of Antigonish. The Town is bounded by Highway 104 to the south, Greening Drive to the west, and West River to the east. The establishments are summarised in Table 6.2.

Table 6.2 Establishments Along The Existing Highway 104, Zone 3 Antigonish

Establishment	Type
South Side Locations	
Sterlings	Farmers' Market
School Bus Lot	Public Building
Power Substation	Utility
Cemetery and Church Building	Church
Small Millwork Building	Small Business
JR Rahey's Appliance	Small Business
Private Homes (3)	Homes (3)
North Side Locations	
Barn	Agricultural Building
Dairy Queen	Restaurant
Private Homes (2)	Homes (2)
Shopping Plaza	Retail
Claymore Inn	Motel/Hotel
Sobey's	Retail
Canadian Tire	Retail
Millennium Centre	Recreation
Tourist Information	Public Building
Hyundai Dealership	Auto Dealership
Fast Track Computer	Small Business
Chateau Motel	Motel/Hotel

Zone 4 is longer compared to the other zones because of the uniform pattern of economic and transportation profile within this zone. An inventory of various establishments along the existing Highway 104 is summarised in Table 6.3.

Table 6.3 Establishments Along The Existing Highway 104, Zone 4 Antigonish

Establishment	Type
South Side Locations	
Irving Gas	Gas Station
Snow Queen	Restaurant
Pete's Auto Sound	Auto Repair Shop
Central Home Decor	Small Business
Shamrock Homes	Small Business
Mother Webbs	Restaurant
Convenience Store	Convenience Store
Petro Canada	Gas Station
Goshen Restaurant	Restaurant
Cape Breton Info Centre	Public Building
Coffee Shop	Restaurant

Table 6.3 Establishments Along The Existing Highway 104, Zone 4 Antigonish

Industrial Park	Transportation/Light Manufacturing
Car Wash	Small Business
Esso	Gas Station
School	Public Building
Private Homes (13)	Homes (13)
North Side Locations	
Highland Professional Centre	Offices
Auto Body Shops (2)	Auto Repair Shop (2)
Oasis Motel	Motel/Hotel
Trailer Park (< 20 units)	Trailer Park (<20 units)
Coastal Inn	Motel/Hotel
Esso	Gas Station
Trailer Park (> 50 units)	Trailer Park (<50 units)
Garage/Body Shop	Auto Repair Shop
Trailer Park Sales	Small Business
Church	Church
Private Homes (8)	Homes (8)

Establishments within the Town of Antigonish but not along the existing Highway 104 are not included in the above inventory of establishments. Based on the above, a summary of businesses with direct access to the existing Highway 104 is provided in Table 6.4.

Table 6.4 Summary of Business Type And Number of Establishments Along The Existing Highway 104 Directly Affected by The Proposed Highway

Business Type	Number of Establishments
Transportation/ Trucking and Light Manufacturing	2
Homes	32
Farmers' Market	1
Convenience Store	1
Gas Station	8
Auto Dealership	3
Auto Repair Shop	4
Restaurant	6
Retail	5
Public/Government Building	5
Small Business	12
Motel/Hotel	4
Recreation/Convention Centre	1
Trailer Parks	2
Church	2

The Berger study used the annual average daily traffic (AADT) to quantify the economic impact on business establishments in consideration of: type of business; location and relative access to points on highway; and market range. The Berger study predicted AADT in the study area assuming no new highway as shown in Table 6.5.

Table 6.5 Average Annual Daily Traffic (AADT) Along The Existing Highway 104 without New Highway

Zone	Base AADT	Growth	1996	2001	2003	2011
Zone 1	6,865 (1992)	3.3%	7637	8725	9203	11389
Zone 2	6,470 (1992)	4.3%	8730	10775	11722	16416
Zone 3	9,150 (1992)	4.9%	11110	14151	15571	22831
Zone 4	8,060 (1992)	8.4%	13545	17287	19059	28159

Source: Louis Berger (Canada) Ltd. 1996

Although the base year for the AADT projection was 1992, recent survey results are consistent with the above projections (refer to Section 6.4 – Transportation Infrastructure for comparative data) except for Zone 4 where AADT in 2002 was lower than that predicted in the Berger study (11,000 vs. 15,800).

The existing Highway 104 also provides an important access to an industrial park situated east of the Town. The industrial park is 101 acres (40.9 ha) complete with water distribution system, storm and sanitary sewers, and fire hydrants.

6.1.2.2 Demographic, Income and Employment Characteristics

The Town of Antigonish has a population of 4,754 (2001 data from Statistics Canada), a decline by 2.2% from the 1996 population of 4,860. Population density in the Town is 923.9 persons per square kilometre over a total land area of 5.15 km^2 (Table 6.6). The County of Antigonish has a population of 19,578 in 2001, a slight increase (0.1%) from the 1996 population of 19,554. Its population density of 13.4 is lower than the provincial average in Nova Scotia of 17.2 persons per square kilometre (Table 6.6).

Table 6.6 Summary of Population, Antigonish Town and County, and Nova Scotia

Characteristics	Antigonish Town	Antigonish County	Nova Scotia
Population in 2001	4754	19578	908007
Population in 1996	4860	19554	909282
1996 - 2001 Population change (%)	-2.2	0.1	-0.1
Total Private Dwellings	2354	8377	403819
Population Density (per km^2)	923.9	13.4	17.2
Land Area (km^2)	5.15	1457.9	52, 917.43

Source: Statistics Canada 2001

The age group characteristics of the Town closely resemble that of Nova Scotia. In general, population in the County is younger with 79.5 % of residents aged 15 years and over as compared to that of the Town (83.5 %) and the provincial average (81.8 %) (Statistics Canada 2001).

The combined population of the Town and County is 24,332, a decline of 0.1 % from the 1996 count of 24,414. The average population density per square kilometre is 16.6. Total land area is 1,463.10 km^2 comprising 2.76 % of the entire area of Nova Scotia (Table 6.6).

Based on the profile of Antigonish published by the ARDA (ARDA 2002), the region's main economic advantage is the stability provided by the educational and health services in the Town. The region enjoys employment opportunities for professionals and non-professional with well-paying positions due to the presence of St. Martha's Regional Hospital (300 employees) and Saint Francis Xavier (St. FX) University (500 employees). In general, the largest employers are public organizations, including the school board in addition to the university and the hospital.

The Statistics Canada census divides Antigonish into three census areas: Town; County Subdivision A; and County Subdivision B. County Subdivision A occupies the western section of the area and surrounds the Town. Subdivision B occupies the eastern section and is relatively more rural compared to Subdivision A. The Project area is contained within Subdivision A. Average annual incomes per person (1996 census data) are similar between Subdivision A ($23,054) and the Town ($22,846). This may be attributed to their proximity to the largest employers present in the area as identified above. Subdivision B, on the other hand, has a significantly lower average annual income of $18,942 (Table 6.7). By gender, reported average income of females is approximately only two-thirds of the reported income of males, which is consistent with the provincial average for less urbanized communities.

Labour participation rate is higher in the County at 66.8% in Subdivision A and 62.5% in Subdivision B as compared to the Town average of 57.1%. Unemployment rate in 1996 was 10.9% in County Subdivision A, which is slightly higher than that of the Town at 9.8%. County Subdivision B suffered a higher unemployment rate of 15.8 %, which is higher than the provincial average of 13.3 %.

Considering employment by major industry classification, 74% of workers are employed in service industries, 14% in manufacturing and construction industries, and 12% in agriculture and other resource-based industries. The share of employment in agriculture and resource based industries is significantly higher in Antigonish County compared to Nova Scotia (7%). This may be attributed to the relatively stronger reliance of the regional economy on agriculture and forestry activities as compared to the rest of the province.

Table 6.7 Income and Employment Characteristics of Population Age 15 Years and Over: Town; Subdivision A; and Subdivision B, Antigonish

Characteristics	Town	Subdivision A	Subdivision B	Total	Nova Scotia
Labour Force Characteristics of Population Aged 15 years and over					
Average Total Income of Persons Reporting Income ($)	22486	23054	18942	-	21552
1996 Unemployment Rate (%)	9.8	10.9	15.8	-	13.3
1996 Participation Rate (%)	57.1	66.8	62.5	-	61
Industry Characteristics of Population Aged 15 years and over					
Agriculture and Other Resource Based Industries	115	505	485	1105	28675
Manufacturing and Construction Industries	175	540	575	1290	71480
Service Industries	1900	2700	2095	6695	324665
Total	**2190**	**3745**	**3155**	**9090**	**424820**

Source: Statistics Canada 1996

Based on 1996 data, retail trade employed most of the work force within the service industries (15.1 % of total) followed by educational services (11.8 %) and health (11.6 %). This is consistent with ARDA observation that the economy of Antigonish relies heavily on health (hospital) and educational services (university and school board). Breakdown by sector is given in Table 6.8.

Table 6.8 Breakdown of Employment by Sector, Antigonish, 1996

Sector	Antigonish	Nova Scotia
Retail	15.1%	13%
Educational Services	11.8%	7.3%
Health	11.6%	10.6%
Accommodation, Food and Beverage Service	9.2%	6.5%
Construction	7.7%	5.9%
Other Service	6.8%	7.3%
Manufacturing	6.2%	10.4%
Agricultural	4.1%	2.3%
Government Service	3.7%	9.6%
Fishing and Trapping	3.6%	2.2%
Logging and Forestry	3.6%	1.2%
All Others	16.6%	23.7%

Source: ARDA 2002

6.1.2.3 Fishery, Forestry and Agriculture

In 1999, Antigonish contributed 1.62 % ($10.02 million) to the total landed value of fisheries in Nova Scotia ($616.96 million). Arisaig Fisheries is among the larger processing plants of lobsters and other shellfish in Antigonish and employs 110 persons (ARDA 2002). Lobster is the main fishery commodity in the region with landed value in 1999 of $8.73 million, followed by blue fin tuna ($870,0000), winter flounder ($158,000), white hake ($113,000), and American plaice ($72,000) (NSDAF 2000). The highway serves an important link for fishery products to various markets in the region.

Pictou Landing First Nation fish salmon in the West and South Rivers and has a fishing plan on file with DFO. Other First Nations members (*e.g.*, Paq'tnkek, formerly Afton) also likely fish in the West and South rivers for food purposes. However, as indicated in the Mi'kmaw Knowledge Study (Appendix K), there is not anticipated to be any significant concerns with respect to First Nations fishing in the study area.

Based on 1997 data, there are 11 sawmills in Antigonish. About 60,000 m^3 of sawn fibre, with over 95 % softwood, were harvested. Roundwood harvest was 5,400 m^3, 76 % of which was hardwood. Sawn fibre production contributed 2 % to the total provincial harvest while only 0.2 % was contributed in provincial roundwood yield. Paper mills Stora (located in Point Tupper, Richmond County) and Kimberly-Clark (Pictou Landing) have employees living in Antigonish. About a kilometre of the new highway alignment will be through managed woodlots impacting at least 15 ha of this land.

The 44 dairy farms in Antigonish contribute about 10 % to Nova Scotia's total production. Scotsburn Cooperative Dairy derives 25 % of its milk from the Antigonish and Guysborough Counties. A total of 20.2 % of the land area of Antigonish is farmland, accounting for 6.9 % of all agricultural farms in the Province. About 33 % of this land is for beef cattle, 22 % for dairy cattle, 21 % for Christmas trees, and 18 % for other crops. There are a total of 247 farms in the County with total value of production of $18.95 million, which account for 4.9 % of Nova Scotia's gross farm income. These data are consistent with the visual inspection conducted, which noted that most of the agricultural lands along the RoW are devoted to pasturage or hay crop production. About 35 ha of this land will be affected by the proposed highway construction.

6.1.2.4 Tourism and Recreation

The Antigonish area is located in northeastern Nova Scotia along the Northumberland Strait and may also be accessed by the scenic highway, the Sunrise Trail.

The Antigonish-Eastern Shore tourism area covers Antigonish County, Guysborough County, and the portion of Halifax County east of a line running from the mouth of the Little Salmon River at Cole Harbour to Gays River. Based on the 2000 Nova Scotia Visitor Traffic Flow Report commissioned by the Nova Scotia Tourism and Culture (2002), Antigonish has the highest traffic levels of communities in the Antigonish-Eastern Shore tourism area, with a total of 428,400 party trips made by 235,200 parties (see Table 6.9 for definitions). It was pointed out that Antigonish is the only community in that area that is located on a 100 series highway, with all other communities located on secondary highways. The area has an estimated capture rate of 21 %, resulting in the highest number of party visits (24,900 party visits), and the highest number of overnight visits (29,900 party overnight trips including a total of 54,200 party nights) in the Antigonish-Eastern Shore Tourism Area.

Table 6.9 shows the overall community visitor traffic flow in this area.

Table 6.9 Overall Community Visitor Traffic Flow, Antigonish-Eastern Shore Tourism Area, 2000

Community	Party Pass Throughs[1]	Party Stops[2]	Party Visits[3]	Overnight Party Trips[4]	Total Party Trips[5]	Parties[6]	Party Nights[7]	Capture Rate in Percent[8]
Antigonish	338800	34800	24900	29900	428400	235200	54200	21
Canso	9000	600	2900	1700	14200	12900	26500	36
Cape George	3700	800	2200	1000	7600	7600	6100	52
Guysborough	17400	1300	1600	1800	22200	19800	3900	21
Isaac's Harbour	17100	400	1800	2900	22200	19800	67500	23
Liscombe	26400	1400	1100	4100	33100	30600	6200	20
Middle Musquodoboit	1000	0	2300	1600	5000	5000	4200	80
Musquodoboit Harbour	30400	2100	5600	4200	42300	38800	18800	28
Sheet Harbour	25200	3400	3100	3700	35400	32400	9200	29
Sherbrooke	20300	1100	9700	3500	34600	31400	4400	41

[1] Represents the number of non-resident party trips passing through or by a specific community without stopping.

[2] Represents the number of non-resident party trips involving a stop of less than one-half hour in a specific community.

[3] Represents the number of non-resident party trips involving a stop of one-half hour or more, but not overnight, in a specific community.

[4] Represents the number of non-resident party trips involving a stop of one or more nights in a specific community

[5] Represents the sum of party pass throughs, party stops, party visits, and overnight party trips for a specific community.

[6] Represents the total number of unique, non-resident parties passing through, stopping, visiting or staying overnight in a specific community.

[7] Represents the total number of nights stayed by non-resident parties in a specific community.

[8] Percent of total party trips through a community that involved a stop, a visit, or an overnight stay.

Source: Nova Scotia Tourism and Culture 2002

With regard to statistics indicating community traffic flow by trip purpose, Antigonish has a capture rate of 26 % of total party business trips, 20 % of total pleasure trips, and 21 % of trips classified as visiting friends and relatives. By region of origin, it has a capture rate of 27 % of all party trips made by visitors from Atlantic Canada, and 18 % each of visitors from other places of Canada and internationally. Overall capture rate is 21 % (Table 6.10).

In summary, it can be concluded that the relatively high capture rate (percentage of total party trips through a community that involved a stop, a visit, or an overnight stay) in Antigonish is attributable, in part, to the immediate presence of the existing Highway 104.

Table 6.10 Community Traffic Flow by Purpose and Origin, Antigonish-Eastern Shore Tourism Area, 2000

Trip Purpose/ Region of Origin	Party Pass Throughs	Party Stops	Party Visits	Overnight Party Trips	Total Party Trips	Parties	Party Nights	Capture Rate (%)
Trip Purpose								
Business	1700	1600	1400	3100	23000	13200	4400	26
Pleasure	143400	9300	10500	16100	179100	99200	21500	20
Visiting Friends/Relatives	118000	16300	8900	7000	150400	82000	22900	21
Other	59800	7500	4200	3700	75100	40500	5200	20
Region of Origin								
Atlantic Canada	99500	20900	8900	7200	136600	74200	9500	27
Other Canada	141000	7800	9900	13000	171700	94500	29400	18
International	98200	6100	6100	9700	120100	66400	15300	18
Overall	338000	34800	24900	29900	428400	235200	54200	21

Note: Refer to Table 6.9 for definition of terms
Source: Nova Scotia Tourism and Culture 2002

Table 6.11 shows a summary of tourism and recreation areas in the Town and County of Antigonish. These include: supervised beaches (2) in Bayfield and Pomquet; provincial parks (5); shared-use trails (6); other trails (5) such as canoe waterways, coastal water trails, sea kayak routes, snowmobile trails, and the Trans Canada Trail; and nature sites (3) including the Antigonish Harbour Wildlife Management Area, Arisaig Sea Cliffs, and Pomquet Beach Region. All of these designated tourism and recreation resources fall outside the highway study area and are not expected to be affected by highway development.

Table 6.11 Municipality of the County of Antigonish Beaches, Parks, Trails and Nature Sites

Category	Feature	Community
Beaches (Supervised)	Bayfield Beach	Bayfield
	Pomquet Beach	Pomquet
Provincial Parks	Arisaig Provincial Park	Arisaig
	Bayfield Beach Provincial Park	Bayfield
	Beaver Mountain Provincial Park	James River
	Cape George Day Park	Cape George Point
	Pomquet Beach Provincial Park	Pomquet
Shared Use Trails	Antigonish Landing Trail	Antigonish Landing
	Arisaig Provincial Park Trails	Arisaig
	Beaver Mountain Provincial Park Trails	James River
	Cape George Hiking Trails	Cape George
	Fairmont Ridge Hiking Trails	Fairmont
	Mahoney's Beach Trail	Mahoney's Beach
Other Trails	Canoe Waterways	Antigonish County
	Coastal Water Trail	Antigonish County
	Sea Kayak Routes	Antigonish County
	Snowmobile Trails	Antigonish County
	Trans Canada Trail	Antigonish County
Nature Sites	Antigonish Harbour Wildlife Management Area	Antigonish Harbour
	Arisaig Sea Cliffs	Arisaig
	Pomquet Beach Region	Pomquet

Source: Municipality of the County of Antigonish 2002

The principal tourism and recreation area of interest for the highway development is the newly built Keating Millennium Centre located in the Town of Antigonish, owned by St. FX University. It houses an information technology (IT) training centre, two ice surfaces, convention facilities, and various fitness and water-related wellness activities. The Town also hosts the Antigonish Highland Games every July, which features Scottish traditions including language, music, dances and songs, along with feats of strength.

6.1.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse effect on the local economy is one that results in a measurable Project-related reduction in total long term local employment or total local business revenues or profitability as a result of an effect on the number of customers and their spending patterns, or on the costs of doing business.

A **positive** effect is one that increases to[illegible]ng term local employment or total business revenues or profitability.

6.1.4 Potential Issues, Interactions and Concerns

The following sections pertain to potential Project-related effects on the local economy. Potential effects on the related VSC, land use, are discussed in Section 6.2.

Commercial Establishments

Throughout the route selection process for the new highway, many members of the business community in Antigonish have expressed concern that the new highway will bypass existing businesses creating a severe loss of business, particularly for those relying on through-traffic for a significant part of their customer base. A related concern was that this adverse effect would be worsened if businesses and other features in the Town could not be seen from the new highway, further reducing the opportunity to attract customers and other visitors. However, a large segment of the community also believes that the new highway could provide the impetus to expand development in Antigonish. This is due to the lack of available expansion area along the existing highway, especially south of the Town.

Most commercial establishments will be at a distance from highway construction activities and will, therefore, be relatively unaffected. Potential traffic disruption and access issues and mitigative measures are discussed in Section 6.2 (Land Use) and Section 6.4 (Transportation Infrastructure). Measures to mitigate potential adverse economic effects on local businesses, as well as to enhance business opportunities related to highway development, will be undertaken primarily through provision of timely Project information and liaison through a Community Liaison Committee (CLC).

Demographic, Income and Employment Characteristics

The new highway will potentially present a wide array of development opportunities. Land use conversion to residential, commercial and industrial uses as a result of improved access tend to increase in-migration and reduce out-migration due to the availability of local employment opportunities. With commercial development near highway exits situated within the County's jurisdiction, an increase in the number of employment in service industries in the County is expected.

Fishery, Forestry and Agriculture

With an approximate length of 15 km and a width of 150 m for the RoW, the total land area along the highway is calculated at 225 ha. The alignment crosses 2.3 km of agricultural land, which is equivalent to a land area of 34.5 ha, crossing farms near South River, Addington Forks Road, Beech Hill Road, and Willowdale Lane. These agricultural areas are mostly devoted to pasturage or hay crop production. The majority of lands crossed by the RoW is wooded, and it is estimated that approximately 1 km of the alignment is along managed woodlots in Beech Hill Road area.

There are no potential issues or concern with regards to the commercial fishing industry or First Nations fishing activity.

Tourism and Recreation

Due to the anticipated improvement of the transportation system brought about by the proposed highway upgrading, tourism and recreational attractions in Antigonish become more accessible. The positive impact may also extend to tourism areas in other areas of the province due to faster travel time as a result of the highway. There are no apparent negative issues or concerns for tourism and recreation facilities. However, as discussed under Commercial Establishments, there are concerns regarding potential negative impacts on tourism-related businesses (*e.g.*, hotels and restaurants) along the existing Highway 104.

6.1.5 Analysis, Mitigation and Residual Effects Prediction

6.1.5.1 Construction

Commercial Establishments, Employment and Income Characteristics

The economic impacts associated with construction are grouped into: (1) potential local construction job creation, and (2) additional economic stimulus (inside and outside the County).

The Berger study (Louis Berger (Canada) Ltd. 1996) indicated that the positive effects during the construction phase of the Project are the resulting job opportunities for local employment, as well as spin-off effects including accommodations, meals, entertainment, and others. The study pointed out that these effects are short term, which will likely disappear when construction activity is completed, or shortly thereafter.

Total construction expenditures are estimated at $81 million over four years, or approximately $20.25 million per year. Based on the experience of typical transportation construction projects in Nova Scotia (using 1999 Nova Scotia economic input-output data), this means approximately $8.1 million per year in direct labour income within the Province. Direct construction jobs are estimated at 55 to 65 over the four-year construction period. Construction job opportunities include positions for carpenters, general labourers, and equipment operators. The extent to which local individuals are hired will depend on the hiring practices of the selected contractors.

Total number of full-time equivalent direct and indirect jobs within Nova Scotia related to construction are estimated at 75 to 90. Total direct and indirect impact on provincial GDP (value-added) is estimated at $19 million per year over four years.

Fishery, Forestry and Agriculture

Agriculture and forestry areas will be incorporated into the new highway RoW with a combined area of about 50 ha and, thus, permanently removed for production. This will result in reduction in agriculture and wood harvests for Antigonish. However, given the total area devoted to agriculture and forest resources in the County (29,485 ha for agriculture alone), the total reduction is not significant. The primary mitigative measure for lost income related to the lost productivity of the land is fair market compensation to be paid to the land owners. Other potential effects are related to lost or lowered productivity associated with fragmentation of land holdings or impeded access. Section 6.2 provides more discussions about Project impacts and mitigating measures on agricultural and forestry land uses. No impact on the commercial fishing industry or First Nations fishing (refer to Appendix K) is anticipated during construction.

Tourism and Recreation

During the construction period and shortly thereafter, there will be a temporary increase in local incomes in Antigonish coming from the employed construction work force and spending on goods and services to supply the Project. A portion of this income is spent in leisure activities or in tourism and recreation. Based on Statistics Canada household spending statistics (1999), 6 % of the household income is spent in recreation. Assuming an increase in local incomes of approximately $4 million per year over four years, (direct and indirect income, further assuming 30% use of local labour), $240,000 per year will go to tourism and recreational revenues. Overall, Project construction will be beneficial to the local economy of Antigonish due to employment opportunities and increased revenue for local businesses. Potential adverse impacts on existing resource use will be, on the other hand, minimal.

6.1.5.2 Operation and Maintenance

Commercial Establishments

In 1998, NSTPW retained Environmental Design and Management Limited (EDM) to prepare a "Visibility Analysis of Alternative Alignments for Highway 104 at Antigonish". The Town was concerned that the future alignment might reduce visibility and commercial potential to the existing businesses which front the current highway as well as the visibility of major landmarks in the town, which could also have an impact on visitation. The study found that the route would afford recognition of major landmarks. Travelling east, there would be no primary views of the James Street commercial area, the Visitor Information Centre, or the Church Street commercial area. However, travelling west, there are prolonged or repeated primary views of the mall, the university, the tourist information buildings and the James Street commercial area.

Due to the visibility constraints, business people in Antigonish are concerned that traffic would no longer stop in Antigonish. As a mitigating measure, a visible Visitor Information Centre near the Trunk 7 interchange is proposed (T. Poder, pers. comm. 2002). NSTPW will explore this option with the appropriate government and regional development agencies. Likewise, landscaping and appropriate signage along the new highway will be helpful to mitigate negative visibility effects, particularly for eastbound traffic.

The Berger study pointed out that without a new highway, there would be growth constraints due to the limiting nature of the roadway system. The study concluded that a new highway will result in economic growth in the County and a favourable impact on the tax base. These growth areas are anticipated to be around the interchange locations.

In order to use the results of the economic model in the Berger study in this socioeconomic assessment, the alternative alignments considered in the Berger report were compared to the proposed alignment. Relevant findings of the Berger study corresponding to the highway sections most similar to the selected alignment were used in this analysis. The Berger study used seven alternatives including the 'no build' scenario. The selected alignment closely resembles some of these alignment alternatives at different zones:

Zone 1	similar in all alternatives;
Zone 2	similar with Alternative III;
Zone 3	similar with Alternative III; and
Zone 4	similar with Alternative IV.

The Berger study modelled the change in the number of customers for different types of businesses. The model results showed that with the new highway alignment, customer-base could drop by as much as 22 to 42 % depending on assumptions of traffic diversion rates and pass-by customer mix (Table 6.12). The most vulnerable establishments are hotels/motels, high turnover businesses with 'sit-down' customers, fast food drive-thrus, gasoline and service stations, and supermarkets. The assumptions used for traffic diversion rates in the Berger report ranged from 40 % (low diversion rate, low pass-by custom mix) to 60 % (high diversion, high pass-by customer mix).

Table 6.12 Projected Change in Customer Base by Business Class

Business Class	Low Diversion Rate Low Pass-By Customer Mix %				High Diversion Rate High Pass-By Customer Mix %			
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 1	Zone 2	Zone 3	Zone 4
Manufacturing, Transport and Public Utilities	--	0	0	0	--	0	0	0
Hotel/Motel	--	-7	-6	-5	--	-42	-38	-34
Small Business Services	--	-11	-10	-9	--	-17	-16	-14
Health Services and Government Services	--	0	0	0	--	0	0	0
Department Stores	--	0	0	0	--	-10	-9	-8
Building Materials/Garden Supply	--	0	0	0	--	-10	-9	-8
Retail Shopping	--	-11	-10	-9	--	-16	-13	-10
High Turnover (Sit Down)	--	-10	-7	-5	--	-29	-26	-22
Fast Food Drive Through	--	-14	-11	-9	--	-25	-22	-18
Auto Body Repair Shop	--	-2	-2	-2	--	-10	-8	-7
Automobile Dealership	--	-2	-2	-2	--	-6	-5	-5
Gasoline/Service Station	--	-15	-12	-9	--	-39	-35	-31
Gas/Service Station with Convenience Store	--	-18	-16	-13	--	-41	-37	-33
Super Market/Farmers' Market	--	-22	-19	-17	--	-36	-32	-28

Source: Louis Berger (Canada) Ltd. 1996

The reduction in the number of customers of commercial establishments along the existing highway was projected, by the Berger report, to be substantial, in some cases. Business owners on James Street claim they will suffer the most as they believe that a large percentage of their customers is through-traffic, and James Street is a usual stopping point due to its visibility and accessibility from the existing highway (J. Parker, pers. comm. 2002).

A more recent study to determine the origin of vehicles on the existing Highway 104 (Beasy Nicoll Engineering Limited 1999) was conducted through a survey of vehicle license plates. The study found that only 30 to 40 % of traffic entering the Antigonish area from the east or west is through traffic. The remaining 60 to 70 % has origin or destination within the study area (NSTPW 1999). This indicates that most highway users are residents of Antigonish. This survey finding contrasts with the 40 to 60 % diversion rate assumed in the Berger report. The impact on existing commercial establishments may not, therefore, be as great as indicated in the Berger model, except for hotel/motel establishments as these cater basically to non-residents and visibility is a major determinant. A further mitigation factor is the overall economic mix in Antigonish, which has a strong economic base in the hospital, academic institutions, agriculture, and other industries.

Another related report was prepared by Professor Ian Spencer of St. FX University who estimated that the new highway would cause a reduction of $8.5 million in annual revenue in Antigonish resulting in a total job loss of approximately 125 full time positions (Spencer 2000). The report only considered potential impacts on existing establishments, and no allowance was given for future gains in new businesses resulting from the project. In essence, it was a short-term potential analysis ignoring any benefits due to construction expenditures, adjustments that businesses may make in response to the new highway, or new economic development opportunities.

A separate study on the economic impacts of highway bypass development was conducted as part of this assessment in order to bring a higher level of confidence regarding the predicted impacts on the Town of Antigonish of the proposed Highway 104 improvements. The study is included as Appendix J. Based on the experience of bypassed communities elsewhere, the opening of a highway bypass will have some short-term negative economic effects. The magnitude of the effects depend on many factors, such as the size of the town, the structure of the economy and the characteristics of its economic "flagships", as well as the response from municipal government and economic development agencies. In general, negative economic impacts tend not to persist in the long-term.

The Berger study estimated that without the highway upgrading, the economic growth of the region will become limited with the projected traffic increases on the existing highway, which was estimated to be over-capacity starting 2003. The Berger study stated that with a 'no build' scenario, the highway will be over capacity by approximately 10 % in Zone 2 by 2011. Zone 3 will be at capacity in 2003 with a potential 52 % over capacity in 2011.

Impacts after construction are greatly dependent on growth-oriented strategies for the area. Beneficial growth strategies include planned growth around interchange locations. Businesses, which are subject to a high degree of pass-by traffic such as gas stations, convenience markets, and fast food restaurants, are likely to develop at highly accessible, and highly visible, locations at interchanges. Development of other establishments at these locations is also likely.

Given the above, it is expected that the positive benefits of the proposed highway upgrading to the local economy will outweigh the negative effects. Proposed mitigating measures to reduce adverse impacts are:

- adequate signage, lighting, and landscape design at highway exits particularly in Addington Forks Road Exit which will serve as the main entry point to the Town where commercial establishments are located; and
- construction of a highly visible Visitor Information Centre near the Trunk 7 interchange.

Suggestions had been made by several members of the business community for an additional interchange at the Church Street Extension to increase access to existing establishments at that location. NSTPW has reviewed this request and concluded that it is not feasible due to the relatively close proximity of the proposed interchange at Trunk 7 (approximately 1 km away) and space limitation due to the presence of the West River.

Demographic, Income and Employment Characteristics

The resulting level of improved access and decongestion on the existing highway is an impetus for development expansion. New areas for commercial and industrial developments will likely occur near interchange locations. As well, a large tract of land along Beech Hill Road, south of the highway, becomes accessible and may become suitable for commercial and industrial land uses. With these anticipated changes in land use, demographic characteristics may be altered as new employment opportunities become available locally. In effect, the out-migration and unemployment rate is expected to decline.

Fishery, Forestry and Agriculture

Since about 3 km of the highway will be along agricultural land and managed woodlots, construction and operation of the proposed highway will result in a permanent loss of agriculture and forestry income to Antigonish. The loss will, however, be insignificant when compared to the total agriculture and forestry resources of the County (29,485 ha for agriculture alone). Due to improved potential of the area to host various industrial activities as a result of the highway, resource-based industries will likely develop and would improve value-added opportunities for agriculture, forestry and fishery products. The highway will also improve the regional transportation system and, therefore, will enhance market access for local produce.

Tourism and Recreation

The upgraded highway will likely be beneficial to the newly built Millennium Centre, located in the corner of existing highway and Trunk 7, due to improved accessibility (J. Parker, pers. comm. 2002). The improved access will also benefit other recreation and tourism sites in the region due to general improvement in transportation network. No adverse effects to this sector are anticipated.

6.1.6 Follow-Up and Monitoring

Monitoring will be undertaken during the construction phase by the Project Engineers to ensure that access to businesses and other establishments are adequately maintained and signage is provided as necessary. Any unusual disruptions to local businesses will be reported to the Project Engineer by the CLC or directly by area residents.

Monitoring during Project operations of long term effects on local businesses and the economy as a result of the new highway will be conducted by the CLC. The committee will periodically report their findings to NSTPW and municipal officials who will jointly determine if any remedial action is warranted. Such remedial action may include adjustments to signage, the Visitor Information Centre, or other measures to encourage economic development in Antigonish.

6.1.7 Summary of Residual Environmental Effects Assessment

It is expected that several commercial establishments along the existing Highway 104 will be adversely affected by the traffic diversion, particularly hotels/motels, restaurants, gas stations and other businesses that rely on through traffic. These adverse effects can be reduced through the application of mitigative measures and are not likely to be significant. The existing highway is considered to be a constraint to current and future economic development due to restricted traffic flows. It is predicted that the new highway will permit new development, particularly near interchanges, that will stimulate local economic activity. It is predicted, therefore, that there will be a net long term benefit to the local economy from the construction and operation of the new highway at Antigonish.

Tables 6.13 and 6.14 summarise the residual environmental effects evaluation for the local economy during Project construction and operation and maintenance.

Table 6.13 Residual Environmental Effects Assessment Matrix
Local Economy (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Socioeconomic Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Land acquisition	• Loss of resource land from production (A)	• Open and early communication with landowners • Adequate planning time • Purchase of land parcels / land swap • Fair and reasonable compensation	1	2	5 / 6	R	2	N	3
Construction of highway	• Disrupted access to recreational lands and commercial areas (A)	• Liaison/information through Community Liaison Committee and municipal officials to reduce disruption and promote economic planning • Traffic Management • Underpass/overpass design to maintain or improve access where practical	1	2	5 / 6	R	2	N	3
	• Job creation and increased disposable income (P)	• No proposed mitigation	2	6	3 / 6	R	2	P	3

Table 6.13 Residual Environmental Effects Assessment Matrix
Local Economy (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Socioeconomic Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		

KEY

Magnitude: 1 = Low: *i.e.*., not significantly affecting local employment or income (*i.e.*, within normal variation); 2 = Medium: *i.e.*, moderately affecting local employment or income; 3 = High: *i.e.*, severe and lasting effects on employment or income

Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects.

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

Table 6.14 Residual Environmental Effects Assessment Matrix
Local Economy (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Socioeconomic Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Diversion of traffic from existing highway	• Decrease in through traffic (increased safety and decreased traffic congestion) along existing Highway 104 (P)	• No proposed mitigation	3	4	5 / 6	R	2	P	3
	• Decrease in customer base at commercial operations along existing Highway 104 (A)	• Ongoing liaison and monitoring through the Community Liaison Committee • Appropriate signage, lighting, landscape design at interchanges • Explore construction of a visible Visitor Information Centre • Strategic planning for the new economic growth	1	3	5 / 6	R	2	N	2
Presence of Highway	• Opening new areas for commercial, residential and industrial development due to increased access (P)	• No proposed mitigation	3	3	5 / 6	R	2	P	3
	• Improved regional transportation system and access to tourism and recreational facilities (P)	• No proposed mitigation	2	6	5 / 6	R	2	P	3

Refer to Table 6.13 for Key.

6.2 Land Use

Land Use is considered a VSC because the proposed highway will directly or indirectly affect the use of land in several ways along the length of the alignment. Any Project-related effect on land use has the potential to alter established patterns of activity within communities. The scope of the assessment of this VSC includes residential, commercial, industrial, resource (*i.e.*, agriculture and forestry) and recreational land uses. Changes in land use also have implications for the local economy which are described in Section 6.1. Noise and air emissions can also affect land uses; these are discussed in Section 5.1. Movement of traffic during construction and operation can also affect land uses; this is discussed in Section 6.4. Effects on Mi'kmaq land and resource use are discussed in Section 6.3 and Appendix K.

6.2.1 Boundaries

The spatial boundary of the assessment has been developed in consideration of the specific types of land use (*i.e.*, residential, commercial/industrial, resource lands) and potential effects (*e.g.*, loss of property, noise). The spatial assessment boundary is generally the study area defined on Figure 1.1.

The temporal boundaries for the assessment of land use include land acquisition during the pre-construction phase and throughout Project construction and operation. Other temporal considerations include the seasonal use of some lands (*e.g.*, residential use during the summer) when users may be subject to greater levels of disturbance. An important temporal consideration for this assessment is that Project construction will not likely commence within at least four years. Land use and other elements of the socioeconomic and biophysical environment may change over that time, and may require re-evaluation as the Project nears development.

6.2.2 Description of Existing Conditions

Existing and planned land uses were determined from 1:50,000 NTS mapping, aerial photographs, and consultation with local planners and development officers, local community members, and local interest groups.

The proposed new highway is situated in the Municipal County of Antigonish. The existing Highway 104 serves as the southern boundary of the Town of Antigonish. Most commercial establishments are situated on the north side of the highway along James Street and Church Street. Agricultural activity in the study area is limited, although fields, pastures, and hay farms do occur. The vast majority of property crossed by the RoW is wooded and has forestry resource use potential. The property configuration along the alignment in Zone 4 consists of primarily long, narrow strips of land, running east to west and southwest to northeast, with only a few residences occurring near the highway. The backwoods areas are largely either left intact or harvested as private woodlots. From 8+400 to the west-end of the alignment, property configuration is primarily running southeast to northwest. No well established recreational land uses within the new RoW area were identified except for the fishing area in South River (Neill and Gunter Ltd. 2001). General land use description by zone is provided below.

Zone 1 From 0+000 to 1+900 or Addington Forks Road

Zone 1 is characteristically rural with an abandoned building on the northern side of the existing highway and storage facilities on both sides. The new RoW will be along the existing highway and veers off south of the Addington Forks exit by about 50 m. An interchange will be constructed at Addington Forks Road including an overpass through the existing Highway 104 connecting to Trunk 4. The RoW will be along four parcels of wooded land adjacent to the existing Highway 104. South of the new RoW are residential buildings located on both the east and west side of the Addington Forks Road.

Zone 2 From 1+900 to 3+800 or James Street

Zone 2 has several commercial establishments located on both the north and south sides of the existing Highway 104. The new RoW will pass through 14 parcels of land, most of which are wooded with a few devoted to pasturage or hay/forage production. Three residential buildings will be affected by the interchange located about 100 m south of the existing highway.

Zone 3 From 3+800 to 6+500 or Beech Hill Road

Zone 3 covers the commercial stretch on the northern section of the existing Highway 104 and St. FX University, mostly within the boundary of the Town of Antigonish. The new highway will cross 15 parcels of land about 80 % of which is woodland. A dairy farm (Riverdale Holstein Ltd.) is located south of the RoW (between 5+900 and 6+100).

There is a proposed interchange at Trunk 7, about 200 m south of the existing Highway 104. The interchange location will cross an abandoned school building and a small business establishment (Crown Tire Services). A service road will be constructed south of the RoW from Trunk 7 eastward to Cunningham Road (Church Street Extension). Cunningham Road connects to Church Street at the northern side of the existing Highway. The road is intended to provide access to farms and residences located south of Kell Road and Cunningham.

Zone 4 From 6+500 to 14+827 or East-end of RoW

The proposed RoW will cross 33 parcels of land. Over 80 % of the area is woodland and the rest is devoted to pasturage or hay/forage crop production. South Side Harbour Road (SSHR) will be relocated to form an exit on the new highway connecting to Route 316. Site inspection on the proposed SSHR relocation and the proposed interchange noted a pre-school about 50 m north of the existing Highway 104 on the east side of SSHR. About 75 m north of the pre-school are four buildings (houses and barns) with a driveway leading to the buildings situated about 125 m north from the existing Highway 104. About 100 m farther north from these buildings are three occupied houses located 40 m east of SSHR. The proposed RoW will cross the farmland including a portion of the buildings. Current land use is pasturage or hay crop production. South River is immediately west of SSHR.

From 10+400 to 10+600, the new highway will cross a derelict building and will eliminate Dunn's Loop. The RoW will cross the existing Highway 104 as an overpass traversing from north of the existing highway to south and will remain south up to the western point of the highway upgrading.

6.2.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect is any Project-related effect that degrades or displaces established or planned land uses, including one that results in an uncompensated permanent loss of renewable rural resources that are used for income generating purposes and/or traditional harvesting activities. Impacts must affect a major portion of land used by a local population and be of long duration or be of such magnitude in the short term that they result in permanent adverse change to land use in the study area.

A **positive** effect is defined as one that enhances the use of lands in the study area including one that enhances the use of rural resources and/or their consequent value.

6.2.4 Potential Issues, Interactions and Concerns

Potential issues of concern related to land use are focussed mainly on the requirement for acquisition of properties within the RoW, and on the effects of highway operation on the remaining adjacent properties. Landowners in either of these situations will be permanently affected by the Project, either through the loss of their properties, or through the continued effects of highway operation. Nearby landowners may be affected by access limitations, air emissions and noise. At least four homes, a commercial establishment (Crown Tire Services) and approximately 60 properties will be directly impacted by the proposed Project.

The diversion of inappropriate through traffic (*i.e.*, trucks) to the new highway from the current route or the existing Highway 104 will likely create positive effects for residential and commercial land use by increasing safety and ease of transit for local residents and business customers. Future land use is potentially affected by the Project as the roadway will preclude any other use of land within the RoW. However the upgraded highway is also likely to promote development in Antigonish and alter land use in the long term (refer to Section 6.1). Without the proposed upgrading, room for expansion is constrained along the existing highway except around Addington Forks Road and Post Road areas. The new highway will provide a good opportunity for development south of Beech Hill Road. It is anticipated that land use in eastern and western sides of the road will change to residential and industrial land uses due to improved access.

The public consultation process undertaken during the highway route selection process has stimulated interest among community groups, business owners, political leaders and individuals to participate in the discussions on local issues and development concerns in Antigonish. In general, those with business interests in the town supported the'red' route (Figure 2.2) (NSTPW 2001a) as opposed to the chosen 'blue' route (subject of this assessment), which also has gained strong support from other sectors of the community. Community discussions have now shifted from the route selection debate to various measures to mitigate the potentially adverse aspects of the highway development.

6.2.5 Analysis, Mitigation and Residual Environmental Effects Prediction

6.2.5.1 Construction

One of the greatest concerns with respect to Project construction effects on residential land use is the acquisition of property within the RoW. Based on property configurations, NSTPW has minimized the number of homes directly affected by the proposed highway by establishing the RoW primarily in the woodland properties. Preliminary RoW mapping (Figure 6.1) indicates that approximately 60 properties, including four homes (directly affected), will be intersected by a portion of the RoW. Acquisition of all or a portion of these properties will be required. The actual number of residential properties and area to be incorporated by the RoW will be determined by NSTPW surveys and assessments during final design of the highway. Lands required for the RoW will be obtained through negotiations with landowners. To the extent that NSTPW maintains open and early communication with affected landowners (through the Community Liaison Committee), and fair and reasonable compensation is paid for property acquisition, with adequate time to allow for relocation, no significant adverse effects are predicted with respect to land acquisition.

The uncertain scheduling of the Project, combined with construction impacts on land use (*i.e.*, noise, air, dust emissions) may make it difficult for residential landowners to sell their properties currently on the market. These effects are expected to be temporary and limited to specific areas directly adjacent to the RoW. With respect to property acquisition by NSTPW, landowners are entitled to a fair market value price for their property.

Following property acquisition for the RoW, the main effects on residential land use during Project construction include air, dust and noise emissions from construction equipment. The significance of these impacts will vary according to the precise location of the property with respect to the alignment, the terrain, and vegetation in the immediate area (*i.e.*, hills and trees may serve to mitigate noise, dust and visual impacts), and according to the subjective attitudes of the residents (*i.e.*, some residents are more sensitive to construction disturbance than others).

Effects from Project construction are most likely to affect residential properties along Addington Forks Road and Trunk 7 including the farm houses near South Side Harbour Road and Taylor Road. In order to minimize the effects of construction activities on residences, noise and dust control measures will be adhered to during construction, and an efficient scheduling will lead to the timely completion of the Project (Refer to Section 5.1 for air and noise mitigation). Appropriate traffic management and realignment of access roads where necessary, will be critical for maintaining access for residential, commercial, industrial and resource purposes (Refer to Section 6.4 for traffic mitigation).

A realignment of South Side Harbour Road will likely result in temporary access restrictions. Similarly, access to Trunk 7, Kell and Cunningham Road (Church Street Extension) will result in access limitations during construction. With the implementation of proper mitigation (e.g., alternative access, signage, traffic controls), however, these limitations are not likely to be significant.

NSTPW or its contractors will provide information throughout the construction phase of the Project to all potentially affected landowners and interested stakeholders to keep them informed of construction activities and progress through the CLC. Construction will be scheduled to minimize the amount of time that individual property owners will be subject to construction activity. The proposed alignment minimizes the number of residences disrupted by the Project, as most of the RoW is located on long properties. Since the vast majority of commercial operations in the area are along the existing Highway 104, no significant adverse effects are predicted for commercial/industrial land use during construction.

Woodland property owned or leased within the RoW (about 15 ha) and a few parcels of agricultural land for pasturage and hay crop production (about 35 ha) will be removed permanently as a resource use or agricultural use. Some of the woodlands may be actively or informally managed for forestry resource. Mitigation for loss of wooded or agricultural land may include outright purchase of land parcels or a land swap with the Province for alternate parcels of property of equivalent value which may be used for forestry activities. Every effort will be made to have open and early communication with landowners, and to provide fair and reasonable compensation for woodland and agricultural areas within the RoW. No direct effects on industrial or institutional landowners are expected.

Agriculture and forestry lands not contained within the RoW will also be affected as access to existing roads may be altered during Project construction. To the extent practical, existing access roads will be maintained during the construction period. If an existing access road can no longer be used, NSTPW will negotiate with the landowner to realign an access road, construct a replacement access, or purchase affected properties.

In summary, concerns during construction include land acquisition, dust and noise emissions, temporary access restrictions and loss of resource lands. No significant adverse effects are anticipated provided that appropriate mitigation measures such as early and open communications with landowners, reasonable compensation, effective scheduling, dust and noise controls and the provision of timely information by the CLC, are implemented.

6.2.5.2 Operation and Maintenance

Some properties near the RoW will not be acquired by NSTPW but will remain in close proximity to the proposed highway during the operation phase. Landowner concerns include: the effect of the Project on property value; access limitations; safety; aesthetic effects; traffic noise; and land and property fragmentation.

The analysis of the potential effect of development of a controlled access highway on the value of adjacent residential properties may only be determined through an exhaustive market analysis. Experiences in both Nova Scotia and New Brunswick have indicated that in general, there is no loss in property value due to proximity to a highway or major road. Site specific analysis would be required to determine the correlation of highway development and property values for a given area. It is considered that other factors more strongly influence property values include: supply and demand; local economic conditions; housing values in other immediate and distant neighbourhoods; presence of schools and other neighbourhood characteristics; and the condition of the house and property.

A controlled-access design is anticipated to reduce the likelihood of vehicle/vehicle and vehicle/pedestrian accidents, as there will be less traffic along the existing Highway 104 than at present. The decreased traffic will contribute to a quieter, safer living environment for residents along this roadway (Refer to Section 6.4). It is anticipated that this improvement of living conditions will entice people to settle along the existing Highway 104, perhaps even attracting settlement from other areas of the Province, Canada and abroad. Noise will have an effect on residential land use near the new RoW. Discussions on noise impacts are presented in Section 5.1.

The Project will have a positive effect on commercial land use along the existing highway by decreasing the frequency of inappropriate traffic, thereby increasing the perceived level of driving and walking safety on this uncontrolled access road. The proposed limited access design, however, may create challenges for developers in determining access points for their concept plans. To mitigate the effect, NSTPW has incorporated new service roads, overpasses, underpasses and interchanges in the highway design. Various underpasses and overpasses are proposed, and full interchanges are planned for Taylor Road, South Side Harbour Road/extension of Route 316 in Lower South River, Dunn's Loop, Beech Hill Road, Trunk 7, and Addington Forks Road or Trunk 4 which will allow access to the new highway. The interchange in Church Street Extension suggested by some members of the business community is not feasible due to its proximity to the required interchange at Trunk 7, space limitations due to the West River and potential residential impacts along Church Street Extension.

Potential effects on agricultural or resource lands include fragmentation and permanent loss of land (refer to Section 6.2.5.1). Potential for micro-climate modifications along the RoW, in particular, changes to cold air drainage patterns, can affect agricultural crops. Project related effects of cld air drainage patterns are likely to be minor since the relief in agricultural areas is small. Furthermore, agricultural land along the RoW is mostly devoted to hay crop production or pasturage therefore any impacts to agriculture are minor. Acquisition of forested land within the RoW will preclude future forestry resource use, resulting in current and future financial losses if uncompensated. The roadway may also limit access to current woods roads, thereby affecting harvesting of forestry resources on these lands. However, the improved roads will likely have positive effects on forestry operations in the area, reducing travel time.

The new highway will have positive effects on land use in Post Road area as it becomes highly accessible considering the interchanges in Addington Forks Road and Trunk 7. The new highway is also seen as an impetus for residential and industrial development south of the highway near Beech Hill Road including lands near the South Side Harbour Road due to the highway exits located in these locations.

Overall, the Project impact on land use during highway operation will be positive due to improved access and diversion of inappropriate traffic to the new highway. It is expected that land use patterns in Antigonish will change over the long term due as the presence of the highway will result in more efficient use of land.

6.2.6 Follow-Up and Monitoring

NSTPW, through the CLC, will remain in close consultation with property owners along the RoW to discuss scheduling, temporary and permanent alternate access roads, and to monitor other Project elements of concern to local residents and landowners. Consultation will also be conducted with owners of forested lands, as applicable, to determine impacts on logging operations and the suitability of access to existing woodlot areas.

6.2.7 Summary of Residual Environmental Effects Assessment

It is anticipated that most direct and indirect effects from Project construction can be effectively mitigated through early notification to potentially affected residents residing in proximity to the RoW, through fair compensation to landowners displaced by the RoW, and standard mitigation measures to reduce effects from noise, dust and traffic disruption. Ongoing effects on land use include noise and proximity of the new highway. Provided that mitigative measures are adhered to, no significant adverse residual environmental effects are predicted. Project operation is expected to produce benefits for land uses by diverting inappropriate traffic away from the residential areas along the existing highway and to open up new lands for development. Tables 6.15 and 6.16 summarise the residual environmental effects evaluation for land use during Project construction and operation and maintenance.

Table 6.15 Residual Environmental Effects Assessment Matrix Land Use (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Socioeconomic Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Land acquisition	• Loss of residential and resource land (A)	• Open and early communication with landowners through a CLC and other mechanisms • Adequate relocation time • Purchase of land parcels / land swap • Fair and reasonable compensation • Maintain access to properties	1	2	5 / 6	R	2	N	3
Construction of highway	• Air, dust and noise emissions (A)	• Noise and dust controls (Refer to Section 5.1) • Restricted working hours	2	2	3 / 1	R	2	N	3

Table 6.15 Residual Environmental Effects Assessment Matrix
Land Use (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Socioeconomic Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Construction of highway	• Disrupted access to residential properties, and commercial, industrial, and resource operations (A)	• Traffic management • Maintain, to extent possible, existing access roads • Underpass / overpass design to maintain access • Negotiate with landowners to realign/construct replacement access roads during construction	1	2	3 / 1	R	2	N	3

KEY

Magnitude: 1 = Low: *i.e.*, not significantly affecting use or enjoyment of property; 2 = Medium: *i.e.*, moderately affecting use or enjoyment of land within a significant portion of the community; 3 = High: *i.e.*, severe and lasting effects on use and enjoyment of land for a significant portion of the community

Geographic Extent: 1 = <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 = 101-1000 km²; 6 = >1000 km²

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

Table 6.16 Residual Environmental Effects Assessment Matrix Land Use (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Socioeconomic Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Diversion of traffic from existing highway	• Decreased through traffic (increased safety and convenience) along existing Highway 104 (P)	• No proposed mitigation	3	4	5 / 6	R	2	P	3
Traffic	• Increased noise levels at residences (A)	• Refer to Section 5.1 for noise mitigation measures	1	2	5 / 6	R	2	N	2
Presence of Highway	• Potentially restricting access to land uses (A)	• Maintain, to extent possible, existing access roads • Realign or construct replacement access roads	1	2	5 / 6	R	2	N	3
	• Permits new development of lands through improved access (P)	• No proposed mitigation	3	3	5 / 6	R	2	P	2

Refer to Table 6.15 for Key.

6.3 Archaeological and Heritage Resources

Archaeological and heritage resources are included as a VSC in this assessment in recognition of the interest of Aboriginal people, the general public as a whole, and provincial and federal regulatory agencies in ensuring the effective management of these resources. For the purposes of this assessment, archaeological and heritage resources are defined as physical remains that inform us of the human use of and interaction with the physical environment. These resources may be above and/or below the surface of the ground and cover the earliest prehistoric times to the relatively recent past.

Heritage resources are generally considered to include historic period sites such as cemeteries, heritage buildings and sites, monuments, and areas of significance to Aboriginal or other groups. Prehistoric refers to the time before the arrival of non-Aboriginal peoples.

6.3.1 Boundaries

Spatial boundaries for the assessment of archaeological and heritage resources include the study area as indicated in Figure 6.1. The assessment of potential Project effects on archaeological and heritage resources is focussed principally on those Project activities that cause ground disturbance.

Temporal boundaries for archaeological and heritage resources consider that these resources are relatively permanent features of the environment. Construction activities carried out at any time of year can therefore affect the integrity of any archaeological or heritage site encountered. Temporal boundaries also consider that archaeological and heritage sites may be affected in the long term by an increase in accessibility.

6.3.2 Description of Existing Conditions

Methodology

The assessment of heritage resource potential within the study area incorporated a number of sources: archaeological site records at the Nova Scotia Museum; historic literature and archival resources; interviews with people knowledgeable of the area; and a visual reconnaissance of the proposed RoW. An additional source of information is the South River Impact Study conducted in October 2000 and the Mi'kmaw Knowledge Study conducted in November 2004. A summary of findings from the impact study (Neill and Gunter Ltd. 2001) is included in this section and a copy of the report is appended in Appendix E. The Mi'kmaw Knowledge Study is included as Appendix K to this report.

Background Research

The study area is located south of the shores of Antigonish Harbour, where a number of pre-Contact archaeological sites have been recorded by the Nova Scotia Museum. The RoW also crosses two major river systems, the West River and the South River. No archaeological sites, prehistoric or historic, have been recorded within the RoW. It is evident that the majority of aboriginal settlement occurred along the shores of Antigonish Harbour where needed resources were much more abundant. The only areas deemed to have high potential for containing pre-Contact archaeological resources were where the RoW crosses the West and the South Rivers. The remainder of the RoW is considered to have low potential as there were no resources available in the past that would have attracted settlement.

Acadian settlement occurred in Antigonish County as early as 1755, in an area east of Antigonish at Pomquet. Black Loyalist settlement of the area was also east of Antigonish, at Tracadie, in 1787. The first historical settlement of the town of Antigonish followed the end of the American Revolution, in 1784. Colonel Timothy Hierlihy led the settlement of 88 people on 21,600 acres of land that became known as the Soldier's Grant. This area lay mainly around the modern town of Antigonish, and north of it, up the harbour around modern day Town Point.

While many of the co-grantees sold off their allotments and left the area after a few years, some remained and became the seed of Antigonish's population. There appear to be only two areas where these early settlers may have impacted the study area. The first is down Kell Road, known locally as the Church Street Extension. The original Kell Road extends south of the study area, which it crosses just beyond the town. Today, it does not follow the full length it did in the nineteenth century, crossing the West River approximately 1 km south of the study area.

Research at Nova Scotia Archives and Records Management and the Antigonish County Museum provided information regarding historical land use in the area. Two maps, in particular Fletcher and Fairbault (1893) and A.F. Church (c. 1869 -1873), indicated that many structures dating to at least the nineteenth century were present near or within the proposed study area. Jocelyn Gillis, of the Antigonish County Museum, was able to identify individuals who could potentially supplement the historical record with local traditional knowledge. Despite consultation with these individuals, no new concerns were brought to light regarding non-Indigenous historical resources within the study area.

While background research indicated a number of potential heritage resources within the RoW, the Nova Scotia Museum had no records of archaeological sites within the study area. Prior to the field survey, a total of nine potential heritage resources were identified through background research.

Mr. Fraser Dunn, a resident of Antigonish, identified an area of concern within the study area alleged to have supported a large Mi'kmaq encampment from approximately 1890-1940. Paq'tnkek Chief Michael Julien did not deny the possibility of such an encampment, but did not indicate any memory of such. Subsequent research has indicated that the encampment was actually a small hill used seasonally for perhaps as much as fifty years by a couple of families. There were no Mi'kmaq people recorded for Antigonish in the 1891 census. One of the people reported to have lived in Mr. Dunn's 'encampment' was Chief John Prosper, purportedly born there in 1879. John Prosper lived, between 1940 and 1945, in a house (PID # 01263888) located on the South Side Harbour Road, near South River Station (Antigonish County Book 5, Dist. 5, Site # 191-290). The write-up for this house on the Inventory Site Form states: "John Prosper, chief of the Mic Mac [sic] Indians, was conveyed the property in 1940…". It also indicates that John Prosper was a labourer. It seems that Mi'kmaq families lived throughout the area of Antigonish until the mid-twentieth century. There is however no memory within the elder community of Antigonish, of any large encampment in the first half of the century. The Mi'kmaw Knowledge Study (Mi'kmaq Environmental Services 2004) did not identify the presence of such an encampment.

The Mi'kmaw Knowledge Study does however indicate current Mi'kmaq land and resource use (e.g., hunting, harvesting) within the study area, most notably around Antigonish Harbour and the South and West Rivers. In particular, there are six areas containing plants of significance to Mi'kmaq for medicinal (73 species), food/beverage (19 species), and craft/art (21 species). These areas are in the vicinity of Sta. 2+000, Sta. 5+500, Sta. 6+500, Sta. 8+500, Sta. 11+500, and Sta. 13+900 (refer to Figure 3 in Appendix K).

Mr. Dunn was also consulted during the South River Impact Study. He was able to provide photos of structures which led to the identification of a feature which was found during the survey: rip rap footing from a bridge located in the area in 1853. He noted other features in the area that have since been destroyed or moved or have turned out to be outside of the Project footprint.

Field Survey

A pedestrian survey was conducted by two licensed archaeologists over the entire length of the RoW. Special attention was paid to areas that had once been cleared and/or cultivated as well as areas of higher elevation. When evidence of historic occupation was encountered, the area was surveyed thoroughly to determine the extent and nature of the occupation. Areas where the RoW crossed major watercourses were considered to have high potential for containing prehistoric archaeological resources and were therefore subject to more intensive surveying and/or testing.

In general, apart from the West and South Rivers, the proposed RoW is considered to have low potential for prehistoric archaeological resources. The stream crossings at the West and the South Rivers were surveyed thoroughly. Both rivers were found at the time (August) to be wide but very shallow and rocky, making them quite unsuitable for navigation even by the most rudimentary of vessels. This is likely the case throughout the year, with the exception, perhaps, of a major spring flood. Both rivers have broad flood plains and there are high terraces on the west side of the West River and on the east side of the South River.

The terrace on the West River (5+600) had been altered significantly during the construction of the modern home now occupying the lot. Although outside of the study corridor, a large knoll north of the RoW was determined to have sufficient potential to warrant subsurface testing with shovels. Three 40 x 40 cm shovel tests were dug but it was determined that most of the terrace had been disturbed to a significant depth.

The west side of the South River has a steep slope running down to the water. A ploughed field on the west edge of this slope was thoroughly examined for evidence of prehistoric occupation but nothing was found. Although the slope on the east side of the river has been destroyed by the construction of the South Side Harbour Road, a large hill to the east was considered to have sufficiently high potential to warrant shovel testing. A series of nine shovel tests was dug between 11+700 and 11+850. All of the tests were negative.

The nine areas where historic period features were identified during background study (Figure 6.1) were examined closely during the pedestrian survey. It was determined that two of the structures (#3 and 6) were still standing and occupied; however, they would not be impacted by construction of the highway. The third (#4), a typical mid-nineteenth century hall and parlour house, which is not normally considered significant, was still standing but had evidently been abandoned for some time. This structure, the A. Fraser house, would likely be impacted by highway construction. No evidence of the remaining six features was found during the field portion of the survey. This may be due to the fact that the structures had been removed or completely destroyed, or that the accuracy of the maps used was not reliable.

The area of the encampment mentioned by Mr. Dunn could only be examined in a cursory manner as access to the land was restricted. It was noted however, that the site had very little to offer in the way of resources and it seems much more likely that a traditional settlement would have been located close to a significant water source at the very least.

The only evidence of historic settlement found during the pedestrian survey was a large (6 x 5 m) rock mound and a north-south running rock wall. The rock mound, located at 3+900, is interpreted as being a field clearing feature. These features are created by the random throwing of stones uncovered during ploughing, into a pile at the edge of the field. These piles often become garbage middens and this mound was littered with artifacts dating from the first half of the twentieth century. The area surrounding the feature was examined thoroughly but no other evidence of occupation was found. A north-south running rock wall was located at 4+100. This low wall may have been related to a cleared field to the south, but a survey of the area failed to find any other evidence of occupation.

Finally, a small cemetery was observed north of the RoW between 10+900 and 11+000. This turned out to be the Lower South River Cemetery, which was well marked and determined to be well outside of the study area.

During the field investigation conducted October 20 and 21, 2000 for the proposed South River crossing, a rip rap bridge footing believed to date from 1853 was discovered. The feature was, for the most part, destroyed by previous construction and/or tidal action. Considering the (recent) age of the feature and its physical state, it was determined to be of low archaeological significance.

6.3.3 Residual Environmental Effects Evaluation Criteria

A **significant** adverse environmental effect is defined as any Project-related disturbance to, or destruction of, archaeological or heritage resources considered by affected First Nations, communities, or provincial heritage regulators to be of major importance due to factors such as rarity, condition, spiritual importance, or research importance, and that cannot be mitigated.

A **positive** environmental effect is one that results in enhanced understanding of local, regional, or cultural heritage through increased knowledge, or provides physical protection for a site that might otherwise have been destroyed through natural or non-Project anthropogenic events, in the absence of the Project.

6.3.4 Potential Issues, Interactions and Concerns

Certain activities associated with Project construction (*i.e.,* grubbing, grading) will cause surficial or subsurface disturbance which could affect archaeological and heritage resource sites. These disturbances, if unmitigated, could result in the loss of the resource and the potential knowledge to be gained from its interpretation. As noted in Section 6.3.2, the proposed RoW has little potential for prehistoric archaeological resources. The four historic resources identified in the two surveys are not considered to be significant.

No other physical evidence of historic resources were uncovered during the October 2000 Neil and Gunter field survey at the proposed South River crossing; however, background information placed a carriage house within the study area, possibly near or under existing buildings or structures, including the existing highway. Although the area has been subjected to significant construction activity, no evidence of the structure has been previously recorded. The report noted that there may be heretofore undiscovered evidence of the structure that has potential to be affected by construction.

The operation phase will not have an adverse effect on significant archaeological resources. If areas beyond the final RoW are not disturbed during maintenance, no other adverse affects on archaeological or heritage resources are anticipated.

In addition to disturbance of archaeological resources, potential impacts to Mi'kmaq land and resource use include temporary and/or permanent loss of access to hunting/kill sites and areas containing plants of significance, as well as loss of individual plants.

6.3.5 Analysis, Mitigation and Residual Environmental Effects Prediction

6.3.5.1 Construction

Project construction will cause surficial or subsurface disturbance which could affect archaeological and heritage resources. Three potential heritage resources were identified within the study area during the course of this assessment. The resources, their significance, and predicted degree of impact are shown in Table 6.17.

Table 6.17 Identified Heritage Resources within the RoW for Proposed Highway 104, Antigonish

Resource	Heritage Significance	Approximate Distance to Centreline	Potential Impact	Recommended Mitigation
Field Clearing Pile	Low	10 m	Likely	None.
Stone wall	Low	15 m	Likely	None.
A. Fraser House	Moderate	30 m	Likely	Mitigation plan to be developed as directed by Nova Scotia Museum which may include recommendation to record the house with photographs.
1853 Bridge Footing	Low	Not Noted	Possible	None

The most significant heritage resource associated with the RoW (10+540) is the dilapidated house, identified as A. Fraser on the A.F. Church map, bordering the RoW. This house dates from the middle of the nineteenth century and is considered to have moderate significance. A mitigation plan will be developed, if necessary, at the direction of the Nova Scotia Museum (NSM). While no recommendations related to the house have been proposed to date by the NSM, such a plan may include recording the house with photographs.

A potential resource identified through background research completed for the South River study was a nineteenth century carriage house. Although no evidence of the carriage house was discovered during field investigations, a recommendation was made to have a trained archaeologist monitor the area during construction of the proposed crossing (Neill and Gunter Ltd. 2001).

Three resources, namely the field clearing, the stone wall and the bridge footing are rated as low in heritage significance, thus no mitigation is required for their anticipated removal during highway construction. Contingency planning will be included in the Project EPP to ensure that appropriate steps are taken to protect and report any new discoveries near these features or elsewhere in the RoW.

In the unlikely event that Mi'kmaw archaeological deposits are encountered during construction, work will be halted and immediate contact will be made with the Nova Scotia Museum and the Confederacy of Mainland Mi'kmaq.

As reported in Section 7.2 of the Mi'kmaw Knowledge Study, the hunting/kill sites that may be affected by the RoW also exist throughout the wider surrounding area; therefore the impact of temporary and/or permanent loss of access to identified hunting/kill sites within the proposed RoW is evaluated as not likely significant. Likewise, the loss of some specimens of plant species of significance to Mi'kmaq is evaluated as not likely significant.

No significant adverse residual environmental effects on archaeological and heritage resources during construction are likely. With the amount of potentially valuable information which has already been and that which may be gathered during construction on archaeological and heritage resources in the general area, the residual effect of the Project could be considered positive.

6.3.5.2 Operation and Maintenance

The primary source of potential adverse effects on archaeological and heritage resources during highway operation is anticipated to be vandalism or inadvertent surficial disturbance at sites due to maintenance procedures. However, access is already available to the one known significant heritage resource (A. Fraser house) within the study area, which is likely to be recorded and removed during the construction phase. Contingency planning will address any new discoveries and provisions will be made for periodic monitoring and evaluation, and worker education as required. There are not likely to be any significant adverse residual environmental effects on archaeological and heritage resources as a result of Project operation.

6.3.6 Follow-Up and Monitoring

Follow-up work for the Project will be undertaken at the direction of the Nova Scotia Museum.

6.3.7 Summary of Residual Environmental Effects Assessment

The development of the Project will involve ground disturbance, which could affect any archaeological or heritage sites that may exist within the zone of surficial and subsurface disturbance. The Project could also result in temporary and permanent loss of access to hunting/kill sites and plants of significance to Mi'kmaq.

Assuming that the required mitigative measures are implemented, there are not likely to be any significant adverse residual environmental effects on archaeological and heritage sites and Mi'kmaq land and resource use. With new information being gathered and made available to researchers, communities, regulators, and other stakeholders, the potential overall effect could be viewed as positive. Tables 6.18 and 6.19 summarise the residual environmental effects evaluation for archaeological and heritage resources.

Table 6.18 Residual Environmental Effects Assessment Matrix
Archaeological and Heritage Resources (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Clearing, grubbing, excavation, blasting, watercourse crossings	• Disturbance of any archaeological, heritage or traditional land use resource (A)	• Mitigation at the A. Fraser house as directed by the Nova Scotia Museum; may include recording the house with photographs • Monitoring of the area of the nineteenth century carriage house during construction of the proposed South River crossing	1	4	2 / 1	I	2	N	3
	• Improved understanding of cultural history (P)	• No mitigation recommended	1	4	5 / 6	N/A	2	P	3

KEY

Magnitude: 1 =Low: *i.e.*, all or part of a site of minor importance, common resource with virtual duplicates; 2 = Medium: *i.e.*, all or part of a site not fully assessed, part of a rapidly depleting group of sites; 3 =High: *i.e.*, all or part of a site considered to be of major importance due to individual attributes or rarity.

Geographic Extent: 1= <500 m²; 2 = 500 m² -1 km²; 3 = 1-10 km²; 4 = 11-100 km²; 5 =101-1000 km²; 6 = >1000 km².

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months.

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200 events/year; 6 = continuous.

Reversibility: R = Reversible; I = Irreversible.

Ecological/Socio-cultural and Economic Context: 1 = Pristine area; 2 = Area affected by human activity; 3 = Evidence of adverse effects.

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect.

Confidence: 1 = Low; 2 = Medium; 3 = High.

Table 6.19 Residual Environmental Effects Assessment Matrix
Archaeological and Heritage Resources (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Road Traffic, Surveillance, Maintenance	• Access to adjacent archaeological and heritage resources and vandalism (A) • Inadvertent disturbance of site surfaces (A)	• No mitigation recommended	1	4	5 / 6	1	2	N	3

Refer to Table 6.18 for Key.

6.4 Transportation Infrastructure

Transportation Infrastructure includes the existing and proposed roads and highways in the study area. Transportation Infrastructure is a VEC because the safe, convenient, economic and efficient movement of persons and goods is essential to travel in and through the study area.

6.4.1 Boundaries

The spatial boundaries (Figure 6.1) for the study include part of Antigonish County, Nova Scotia, near the Town of Antigonish and include the following:

- West - just west of the existing Highway 104 / Trunk 4 / Addington Forks Road intersection;
- North - areas adjacent to the existing Highway 104 from west of the Trunk 4 / Addington Forks Road intersection to east of the Taylor Road intersection;
- East - the areas adjacent to the Taylor Road intersection, east of Lower South River; and
- South - areas adjacent to the proposed Highway 104 from west of the Trunk 4 / Addington Forks Road intersection to east of the Taylor Road intersection.

The temporal boundaries during which the Project will affect transportation include both construction and operation phases. Although construction scheduling is uncertain at this time, it is expected to be spread over a two to four year period. The operation phase for the new Highway 104 will be ongoing.

6.4.2 Description of Existing Conditions

Volumes

During the summer of 2002, machine traffic counts were obtained at various locations throughout the study area to provide count data needed to estimate 2002 AADT volumes. Estimated 2002 AADT volumes, calculated from these counts and supplemented with data recorded in the Highway 104 Antigonish Safety Review (Beasy Nicoll Engineering Ltd. 1999) as well as available 1999 to 2001 machine counts supplied by NSTPW, are included in Table 6.20.

Volumes on Highway 104 are high for a predominantly two lane highway without access control. The 2002 AADT volumes vary from 8,400 vehicles per day (vpd) west of the study area, to 10,000 to 15,000 vpd throughout various sections of the study area. NSTPW historical count data indicated that growth rates are about 3 % per year west of the study area, about 2.5% per year west of James Street, and 2% per year for segments east of James Street. AADT volumes for 2002 have been factored, using the 2% to 3 % simple annual percentage growth rates, to project estimates of 2022 AADT volumes, which are also included in Table 6.20.

Table 6.20 AADT Volumes for Existing and Proposed Highway 104 Segments

Route Segment	AADT Volumes on Existing Segments (Without New Highway 104)		AADT Volumes on Existing and Proposed Segments (With New Highway 104)	
	2002[1]	2022[2]	2002[3]	2022[2]
Existing Highway 104 Segments				
West of Addington Forks Rd.	8,400	13,400	8,400	13,400
Addington Forks to SuperValu	10,600	15,900	4,800	7,200
SuperValu to James Street[4]	12,400	18,600	6,000	9,000
James St. to Trunk 7	10,200	14,300	4,300	6,000
Trunk 7 to Church St.	12,300	17,200	3,600	5,000
Church St. to Beech Hill Rd.	14,200	19,900	5,500	7,700
Beech Hill Rd. to Trunk 4 (East)	13,700	19,200	1,400	2,000
Trunk 4 (East) to Central Supply Area	15,800	22,100	3,500	4,900
Central Supply Area to Route 316	14,400	20,200	2,600	3,600
Route 316 to Industrial and Mobile Home Parks	13,000	18,200	3,900	5,500
Industrial and Mobile Home Parks to Taylor Rd.	11,000	15,400	1,200	1,700
East of Taylor Rd.	10,100	14,100	-	-
Proposed New Highway 104 Segments				
Addington Forks Rd. to Trunk 7	-	-	6,400	10,200
Trunk 7 to Beech Hill Rd.	-	-	8,700	12,200
Beech Hill Rd. to Route 316	-	-	12,700	17,800
Route 316 to East of Taylor Rd.	-	-	10,100	14,100

NOTES:
1. The 2002 AADT volumes were obtained or factored from volume data recorded in the *Highway 104 Antigonish Safety Review* (Beasy Nicoll Engineering Ltd. 1999) and updated using available 1999 to 2002 machine counts supplied by NSTPW.
2. The 2022 AADT volumes were projected from 2002 volumes using 3 % simple annual growth rate for sections west of Addington Forks Rd., 2.5% for Addington Forks Rd. to James Street and 2% simple annual growth rate for sections east of James Street.
3. Volumes for existing and proposed Highway 104 segments have be estimated by updating the volume information from *Highway 104 Antigonish Safety Review* (Beasy Nicoll Engineering Ltd. 1999).
4. The Antigonish Education Centre access road, opening in Spring 2003, will remove about 2000 AADT from the SuperValu to James Street segment. This has reduced the volume from 14400 to 12400 AADT. (Source: Atlantic Road and Traffic Management 2002).

Daily volumes fluctuate from one time of year to another, with volumes typically higher in the summer and lower in the winter. NSTPW maintains a permanent count (NSTPW 2001c) and vehicle classification station at Marshy Hope, approximately 15 km west of the study area. Volume data from the permanent counter were used to calculate the seasonal volume variations for the study area for the three times of year indicated in Table 6.21.

Table 6.21 Seasonal Variation in Average Daily Volumes

Season	Average Daily Volume as a Percent of AADT
Winter (December, January, February, March)	76 %
Spring / Fall (April, May, October, November)	100 %
Summer (June, July, August, September)	137 %

Source: NSTPW 2001c

The traffic stream on Highway 104 is composed of a mix of passenger cars, vans, light trucks, heavy single unit trucks and tractor trailer units. The vehicle classification mix for Highway 104 is shown in Table 6.22.

Table 6.22 Vehicle Classification for Study Area of Highway 104

Vehicle Type	Description	Percent
Passenger	Cars and vans	83
Trucks	Single Unit, 2 axle	6
	Single Unit, 3 axle	2
	Semi Trailer, 5 and 6 axles	9

Source: NSTPW 2001c

Road Types and Widths

Road types and widths are shown in Table 6.23. Highway 104 generally has a good paved surface, including climbing lanes and auxiliary turning lanes at appropriate locations. Generally, the highway provides two through lanes throughout the study area, with the exception of a 2 km segment of narrow, curbed median, four lane roadway from just west of James Street to just east of Church Street. The alignment throughout is suitable for the posted speed limits.

Table 6.23 includes existing cross section characteristics of roads that will be affected by Project construction. Access management and interchange construction will cause major changes to most of the roads crossed by the proposed alignment.

Table 6.23 Existing Road Types and Widths in Study Area

Location	Surface Type	Travel Width (m)	Shoulder Width (m)	Construction Impact
Addington Forks Rd.	Paved	6.5	2.0 both sides; gravel	Interchange Location
Trunk 7	Paved	6.2	1.6 west - paved with curb 2.2 east - gravel	Interchange Location
Kell Rd.	Dirt	6.4	n/a	Cut-off; access via service road to Trunk 7
Cunningham Rd. (off Church Street Ext.)	Dirt	6.3	n/a	Cut-off; access via service road to Trunk 7
Beech Hill Rd.	Gravel	5.1	n/a	Interchange Location
South Side Harbour Rd.	Paved	7	0.0 west 1.1 east - gravel	Cut-off and diverted to Route 316 Interchange
Taylor Rd.	Paved	6	1.1 both sides - gravel	Diverted to overpass New Highway 104

Source: Field observations and measurements for road characteristics, and NSTPW alignment plans for construction impacts

Speed Limits

There are nine speed zones involving four speed limits on existing Highway 104 in the study area (Table 6.24). The combined effect of the multiple speed zones is an average speed of approximately 80 km/hr throughout the study area. Actual travel speed is also affected by traffic conditions and traffic signal timing at the signalized SuperValu, Trunk 7 and Church Street intersections.

Table 6.24 Number and Lengths of Speed Zones in Study Area

Posted Speed Limit (km/hr)	Number of Speed Zones	Total Length Each Posted Limit (km)
60	1	0.75
70	1	3.95
80	4	3.45
90	3	4.75
Totals	9	12.9 [1]

Note: 1. The total length is longer than the distance between Addington Forks Rd. and Taylor Rd. since the reduced speed zones extend east and west of the actual study area.

Source: Field measurements using a vehicle odometer.

Collision Rates

During the ten year period from 1992 to 2001, the 12.1 km section of Highway 104 between Addington Forks Road and Taylor Road experienced 304 property damage only (PDO), 128 injury and one fatal collisions. The break down of annual collisions by severity for four sections of the study area is shown in Table 6.25. Collision rates expressed as number of collisions per hundred million vehicle kilometres (HMVK) are also included in the table.

Table 6.25 Number of Collisions and Collision Rates-1992 to 2001

			Number of Collisions				Collision Rates			
Year	AADT	HMVK	PDO	Injury	Fatal	Total	PDO	Injury	Fatal	Total
Highway 104 Section 275 (Addington Forks Rd. to James Street; 2.19 km)										
1992	7,510	0.0602	9.0	2.0	0.0	11.0	149.5	33.2	0.0	182.7
1993	7,740	0.0619	7.0	5.0	0.0	12.0	113.1	80.8	0.0	194.0
1994	7,970	0.0637	12.0	1.0	0.0	13.0	188.4	15.7	0.0	204.1
1995	8,370	0.0669	5.0	2.0	0.0	7.0	74.7	29.9	0.0	104.6
1996	8,620	0.0691	5.0	3.0	0.0	8.0	72.4	43.4	0.0	115.8
1997	8,880	0.0710	3.0	5.0	0.0	8.0	42.3	70.4	0.0	112.7
1998	8,900	0.0711	2.0	1.0	0.0	3.0	28.1	14.1	0.0	42.2
1999	9,490	0.0759	3.0	2.0	0.0	5.0	39.5	26.4	0.0	65.9
2000	11,000	0.0882	2.0	2.0	0.0	4.0	22.7	22.7	0.0	45.4
2001	11,000	0.0879	2.0	5.0	0.0	7.0	22.7	56.9	0.0	79.6
Totals / Averages		0.71585	50	28	0	78	69.8	39.1	0.0	109.0

Table 6.25 Number of Collisions and Collision Rates-1992 to 2001

Year	AADT	HMVK	Number of Collisions				Collision Rates			
			PDO	Injury	Fatal	Total	PDO	Injury	Fatal	Total
Highway 104 Section 280 (James Street to Trunk 7; 0.50 km)										
1992	6,620	0.0121	1	1	0	2	82.5	82.5	0.0	165.1
1993	6,800	0.0124	6	2	0	8	483.5	161.2	0.0	644.6
1994	7,300	0.0133	4	3	0	7	300.2	225.2	0.0	525.4
1995	7,510	0.0137	3	0	0	3	218.9	0.0	0.0	218.9
1996	7,700	0.0141	2	2	0	4	141.9	141.9	0.0	283.9
1997	7,930	0.0145	2	0	0	2	138.2	0.0	0.0	138.2
1998	8,050	0.0147	6	0	0	6	408.4	0.0	0.0	408.4
1999	10,270	0.0187	9	2	0	11	480.2	106.7	0.0	586.9
2000	10,420	0.0191	6	1	0	7	314.7	52.4	0.0	367.1
2001	10,200	0.0186	4	3	0	7	214.9	161.2	0.0	376.0
Totals / Averages		0.1512	43	14	0	57	284.3	92.6	0.0	376.9
Highway 104 Section 285 (Trunk 7 to Church Street; 1.08 km)										
1992	9,200	0.0364	5	2	0	7	137.5	55.0	0.0	192.5
1993	9,400	0.0371	4	2	0	6	107.9	54.0	0.0	161.9
1994	9,500	0.0374	5	2	0	7	133.5	53.4	0.0	186.9
1995	10,190	0.0402	10	0	0	10	248.9	0.0	0.0	248.9
1996	10,400	0.0411	4	1	0	5	97.3	24.3	0.0	121.6
1997	10,800	0.0426	3	1	0	4	70.5	23.5	0.0	94.0
1998	10,960	0.0432	6	1	0	7	138.9	23.1	0.0	162.0
1999	11,860	0.0468	6	5	0	11	128.3	106.9	0.0	235.3
2000	12,220	0.0483	4	2	0	6	82.8	41.4	0.0	124.2
2001	12300	0.0485	4	1	0	5	82.5	20.6	0.0	103.1
Totals / Averages		0.42147	51	17	0	68	121.0	40.3	0.0	161.3
Highway 104 Section 290 plus 1.75 km of Section 300 (Church Street to Taylor Rd.; 8.37 km)										
1992	11,100	0.3400	24	3	1	28	70.6	8.8	2.9	82.3
1993	11,300	0.3452	13	2	0	15	37.7	5.8	0.0	43.5
1994	11,600	0.3544	17	8	0	25	48.0	22.6	0.0	70.5
1995	12,400	0.3788	20	11	0	31	52.8	29.0	0.0	81.8
1996	12,700	0.3891	24	13	0	37	61.7	33.4	0.0	95.1
1997	13,100	0.4002	10	7	0	17	25.0	17.5	0.0	42.5
1998	13,300	0.4063	18	5	0	23	44.3	12.3	0.0	56.6
1999	13,400	0.4094	12	7	0	19	29.3	17.1	0.0	46.4
2000	13,600	0.4166	10	9	0	19	24.0	21.6	0.0	45.6
2001	13,800	0.4216	12	4	0	16	28.5	9.5	0.0	38.0
Totals / Averages		3.8617	160	69	1	230	41.4	17.9	0.3	59.6

Note: AADT-Average annual daily traffic

HMVK-Hundred million vehicle kilometres

PDO-Property damage only

Source: NSTPW collision data base and published collision data

Collision rates are the number of collisions per unit exposure. The collision rates noted for Section 290 compared with the other Sections detailed in Table 6.25 are significantly lower. There is a difference in the number of driveways and intersections in the various sections. There are two intersections and thirty three driveways from Addington Forks to Church Street, while there are seven intersections and forty three driveways between Church Street and Taylor Road. It is further noted that the other sections in the study area are shorter and have a smaller HMVK column. Section 290 has a higher volume but is significantly longer, exceeding by 6 km the length of the second longest section, (275) which is 2.19 km in length, than the sections described in the table. The volume and the number of driveways and intersections along Section 290 are 'smoothed out' by the length of the section.

The relative safety of a section of highway is evaluated by comparing study area collision rates to the average collisions rates for all similar highways in the Province. NSTPW periodically publishes collision statistics that include five year average collision rates by severity and by highway class. *Motor Vehicle Collision Rates for Numbered Highways and Sections 1996 to 2000* (NSTPW 2002a) is the most recent publication. The study area is considered a 100 Series No Access Control road. Collision rates for this area of Highway 104 are included in Table 6.26 for the five years from 1996 to 2000, and the ten years from 1992 to 2001 (NSTPW 2002b). The Provincial five year (1996 to 2000) average collision rates for all sections of two-lane '100 Series No Access Control' and 100 Series Full Access Control, as well for Four-Lane Wide Median 100 Series Highways are included for comparison.

The Five Year 1996 to 2000 blended or combined PDO collision rates for the 12.1 km of highway within the study area are about 40% higher than the comparable five year average for all provincial 100 series highways without access control. The study area rate is also about twice the rate for four lane divided wide median highways for the five year period. While injury rates in the study area are comparable to the provincial average for all provincial 100 series highways without access control, they are also about twice as high as the rate for four lane divided wide median highways for the five year period. There were no fatal collisions within the study area of Highway 104 between 1996 and 2000, and only one fatal collision between 1992 and 2001.

Table 6.26 Collision Rate Data for Highway 104 Compared with Provincial Averages

Road Class	Collision Rates by Severity		
	PDO	Injury	Fatal
Five Year (1996 to 2000) Provincial Average Collision Rates [1]			
2 lane Arterial (100 Series No Access Control)	36.6	23.2	1.2
2 lane Arterial (100 Series Full Access Control)	31.5	16.6	1.5
4 lane Freeway (100 Series Wide Median)	24.1	11.2	0.6
Five Year (1996 to 2000) Collision Rates for Highway 104 Study Area [1]			
Addington Forks Rd. to James Street	40	34.7	0
James Street to Trunk 7	308.6	61.7	0
Trunk 7 to Church Street	103.7	45.1	0
Church Street to Taylor Rd.	36.6	20.3	0
Blended Sections - Study Area (1996 to 2000)	**50.8**	**25.6**	**0**
Ten Year (1992 to 2001) Collision Rates for Highway 104 Study Area [2]			
Addington Forks Rd. to James Street	69.8	39.1	0
James Street to Trunk 7	284.4	92.6	0
Trunk 7 to Church Street	121	40.3	0
Church Street to Taylor Rd.	41.4	17.8	0.3
Blended Sections - Study Area (1992 to 2001)	**59**	**24.9**	**0.2**

Sources: 1. *NSTPW 2002a.*
2. *NSTPW 1997b.*
– Section collision tallies for 2001 from NSTPW.

Number of Accesses

There are approximately 25 street or road intersections in the study area, eight of which carry significant volumes, including the three which have traffic signals (Super Valu, Trunk 7 and Church Street). There are also about 76 entrances to residential, commercial, agricultural and institutional locations. The locations of the road intersections and the distribution of driveway entrances from Addington Forks Road to Taylor Road are shown in Table 6.27.

Table 6.27 Locations of Road Intersections and Driveways

kms Eastbound from Aorks Rd.		Intersecting Roads (N - North side; S - South side)	Number of Driveways		
From	To		North Side	South Side	Total
0	1	Trunk 4 (N) and Addington Forks Rd. (S) Somers Rd. (N)	10	4	14
1	2	**New School Access Rd.** (N) and **SuperValu** (S); NSTPW Office (N); MacIsaac Rd. (N)	12	4	16
2	3	James Street (N); **Trunk 7** (N and S)	0	2	2
3	4	Cemetery Entrance (S); **Church Street** (N and S)	1	0	1
4	5	Willowdale Lane (N and S); Beech Hill Rd. (N and S)	0	0	0
5	6		0	2	2
6	7		0	0	0
7	8	Trunk 4 (N); Silver Birch Drive (S)	4	5	9
8	9	MacEachern Loop (N - 2 intersections); Dunn Loop (N)	0	2	2
9	10	Dunn Loop (S); South River Loop (S); Dunmore Rd. (S)	0	0	0
10	11	South Side Harbour Rd. (N); Route 316 (S);	8	10	18
11	12	Mobile Home Park (N); Residential Street (S); Industrial Park Roadway (S)	2	9	11
12	End	Taylor Rd. (N)	1	0	1
	Totals		38	38	76

Note: Intersection names in **bold text** have traffic signals. Other intersections have STOP sign control on the side road.

Source: Site visit observations and NSTPW location plans

6.4.3 Residual Environmental Effects Evaluation Criteria

Transportation infrastructure is evaluated as being 'safe, convenient, economic and efficient' by consideration of level of service or performance, and safety as indicated by collision rates.

A **significant** adverse environmental effect is one in which:

- the traffic flow is altered at many areas that currently have satisfactory levels of traffic performance so that the levels of performance are reduced to levels unacceptable or undesirable by engineering standards or professional judgment; or

- the collision rate at one or more locations throughout the study area increases above existing rates for the location(s), or Provincial average rates for the road class, so as to increase the number of collisions in the study area.

A **positive** environmental effect is one that:

- provides improved levels of service or performance, by increasing capacity or diverting or reducing traffic volumes; or
- improves safety by reducing the number of collisions throughout the study area.

6.4.4 Potential Issues, Interactions and Concerns

There will be some interaction between the Project and transportation infrastructure during the construction phase as construction vehicles use some sections of area roadways to access the construction site. Construction impacts will also occur at areas where the proposed highway crosses existing roads and at the western and eastern extremities of the alignment where the proposed and existing Highway 104 alignments meet. Construction phase impacts may include traffic delays, detours and additional construction vehicles operating in the area.

The Project will become part of the transportation infrastructure since it involves construction of a new Highway 104 alignment in the Antigonish area. Therefore, the greater interactions between the Project and transportation infrastructure will occur when a large percentage of traffic on the various sections of the existing highway between Addington Forks Road and Taylor Road is diverted to the new fully operational Highway 104. This improvement will have a number of benefits for members of the public travelling through the area including improved traffic flow and safety. In fact, these improvements are the reason for the Project.

It is a good policy for new 100 series highways to provide access to provincial trunk highways, and Trunk 7 is a major entrance to Antigonish, Saint Francis Xavier University and the Millennium Centre. Trunk 7 is a major access to Guysborough County and a direct connection is seen as a very important interchange from Highway 104 to Trunk 7 for an expeditious link to the town and the other above noted key locations. The interchange provides access to the town with minimal impact to other roads.

Issues and concerns associated with potential interaction between the Project and transportation infrastructure include the following.

- The proposed Highway 104 alignment will sever the Church Street Extension.
- The proposed alignment will sever many properties; property accesses must be maintained.

- Appropriate access points must be provided to connect existing transportation infrastructure to the proposed Highway 104 alignment.

6.4.5 Analysis, Mitigation and Residual Environmental Effects Prediction

6.4.5.1 Construction

The road construction process comprises several phases which generally include survey and design, grading, construction of overpasses/underpasses and interchanges, and paving. Each step has potential effects on transportation infrastructure.

Survey and design

During the survey and design phase, the existing topographical features of the proposed alignment are recorded by a field survey. Field survey data, together with available mapping of the study area and the highway design criteria, are used by design engineers to establish the vertical and horizontal design details of the proposed highway alignment. The design of treatments for intersected roadways, such as severing or provision of a service road or construction of an overpass, underpass or an interchange, is also included in the design phase.

The field survey has the potential to affect the existing transportation infrastructure at areas where survey crews must work on or near existing roadways at both ends of the alignment and at intervening roadway crossing points. When working on a roadway driving surface or shoulders, survey crews will be required to use signs, traffic control persons and warning devices as prescribed in the most recent edition of Nova Scotia Temporary Workplace Traffic Control Manual.

Since design does not have immediate impacts on roadways, and field survey involves only minimal work on or near the roadway, significant effects on transportation infrastructure are not anticipated during the survey and design phase.

Grading

Grading involves re-contouring existing ground levels throughout the alignment to provide a roadbed that is suitable for the horizontal (curves) and vertical (hills) alignments that comprise the design for the proposed highway. Roads and properties that will be severed by the highway will typically be severed during this phase.

Since the proposed alignment parallels and does not use the existing Highway 104 RoW, much of the grading phase will be completed without affecting traffic using existing transportation infrastructure. At the west and east ends of the Project, where the new and existing Highway 104 will connect, grading will be carried out with minimal effect to existing traffic. Grading activities and crossing construction traffic will occur at minor road locations, and at one crossing of the existing Highway 104 in Lower South River, along the new alignment where overpasses/underpasses will be constructed. Local roads will be used to access the various construction sites along the new alignment; these will be restored as necessary after construction is complete. Signing for all construction activities will be as prescribed in the most recent edition of Nova Scotia Temporary Workplace Traffic Control Manual.

NSTPW considers existing property boundaries during highway route location and design in an attempt to minimize the number of properties that will be affected and to reduce the impacts on properties that must be crossed by the proposed roadway. When properties are severed, NSTPW will either purchase minor severed portions, or provide access across the new highway by a series of access roads and access road crossings under the highway.

Both Kell and Cunningham Roads, two dirt roads south of Church Street Extension, will be severed from Church Street Extension by the Project alignment. A service road is proposed to provide alternate access to Trunk 7, about 1 km west of where the roads will be severed. Since traffic volumes are very low on these roads, and since the service road will provide direct access to Trunk 7 in close proximity to a new Highway 104 interchange, impacts are not considered to be significant.

South Side Harbour Road will also be severed by the Project, however safer and improved access to existing traffic on this road will be provided by the proposed alignment to meet the extension of Route 316 at a new Highway 104 interchange.

The grading phase will not have a significant effect on transportation infrastructure.

Overpasses, Underpasses, and Interchanges

Since the Project will involve construction of a fully controlled access highway, overpasses or underpasses will be required to grade separate roadways that are crossed by the proposed Highway 104; interchanges will be required to allow access to/from the Highway.

Construction of overpasses, underpasses, and interchanges will occur at various times throughout the two to four year construction period. Impacts to existing transportation infrastructure will generally be confined to areas immediately adjacent to each construction site. Traffic volumes at most intersecting roads are low to moderate, so effects which may occur will not cause significant problems on minor roads. Signing for all construction activities, including short detours that may be required, will be as prescribed in the most recent edition of Nova Scotia Temporary Workplace Traffic Control Manual. Construction of overpasses, underpasses and interchanges will not have a significant effect on transportation infrastructure.

Pavement

The final phase to complete the highway and prepare it to receive traffic involves installation of pavement, pavement markings, guide rail, and signs. Also, during this phase the final grading and paving is done to complete the transition sections at west and east ends of the Project. This will complete Highway 104 as a four lane divided controlled access highway from west of the Addington Forks Road to east of Taylor Road. Connections to the existing Highway 104 at both ends will provide continuity of travel so that traffic on Highway 104 travelling through Antigonish County will move seamlessly from the existing Highway 104 to the new Highway 104.

Although some trucking of paving materials will be required on area roads, it is anticipated that asphalt or concrete batch plants will be located close to the Project to minimize trucking costs. Signing for all construction activities, including short detours that may be required, will be as prescribed in the most recent edition of Nova Scotia Temporary Workplace Traffic Control Manual. Paving and installation of pavement markings, guide rail, and signs will not have any significant adverse effects on transportation infrastructure.

6.4.5.2 Operation and Maintenance

The purpose for the Project is to construct a four lane divided Highway 104 to replace the existing uncontrolled access section from west of the Addington Forks Road intersection to east of Taylor Road. The existing Highway 104, has numerous driveways and intersections, three sets of traffic signals, is speed zoned between 60 and 90 km/hr throughout its length, and carries a mixture of local traffic and through traffic. The opening of the new Highway 104 and the removal of through traffic, as well as a considerable amount of local traffic, from the existing highway will have a positive effect on transportation infrastructure in the area.

Calculation of average speed in this report considers the average of posted speed limits. In the study area, there are three sets of traffic signals which would further reduce speed however, each is fully traffic actuated to minimize impacts or delays to Highway 104 traffic. While there are traffic signals present along the area, this is not factored into the calculations. To calculate the overall average, inclusive of traffic signals, it would be necessary to develop a weighted average of the existing speed limits, factor in stop time, the length of each speed zone and the overall length of the study area.

There are nine speed zones involving four speed limits on existing Highway 104 in the study area. The combined effect of these speed zones reduces the average travel speed through the area to under 80 km/hr, compared to the usual 100 km/hr on two lane controlled access highways, and 110 km/hr on four lane divided wide median highways in Nova Scotia. Delays from traffic signals (red lights) would further reduce this. The proposed Highway 104 will be posted at 110 km/hr. The diversion of long through-trips to the new highway will greatly increase the percentage of short local trips on the existing road, which may provide a small reduction in travel speeds.

The most noticeable change from the construction of the Project will be the diversion traffic from the existing road to the new highway. The proximity of the proposed alignment to the existing alignment and provision of four strategically located interchanges will divert both through traffic and a considerable amount of local traffic to the new highway. Volume information from Highway 104 Antigonish Safety Review (1999) has been reviewed and updated to provide 2002 and 2022 AADT estimates of diverted and residual volumes on the proposed and existing Highway 104 alignments. AADT volumes for 2002 and projected 2022 AADT volumes for both existing and proposed highway sections are included in Table 6.20.

Between 50 and 80 % of the traffic on the existing Highway 104 will likely divert to the new highway. While traffic collisions are inevitable, the new Highway 104 is expected to have a significantly improved collision rate compared with the existing Highway 104. Since this will be a new controlled access four lane divided highway with a wide median, collision rates are expected to be considerably lower than those on the existing two lane highway without access control. Large reductions in traffic volumes on the existing road will improve the ease and safety of access for the many road and driveway entrances throughout the study area. Also, since most of the heavy trucks will divert to the new highway, public concerns for safety and noise along the existing Highway 104 will be reduced.

With the completion of the Project, the study area will be served by four interchanges:

- Addington Forks Road and Trunk 4 (west end);
- Trunk 7;
- Beech Hill Road; and
- Route 316 (east end).

Appropriate auxiliary turning lanes on the existing or reconstructed intersected roadways will be included in the design interchange ramp terminals for each of the interchange locations where deemed necessary.

In summary, operation of the new section of Highway 104 will create a number of long term benefits for motorists in the study area including improved traffic flow and safety. These benefits will be more pronounced over time as traffic volumes in the study area are predicted to increase significantly.

6.4.6 Follow-Up and Monitoring

There will not be any need for any special follow-up or monitoring of impacts on transportation infrastructure. Traffic counts will continue to be obtained every three years on the existing roadway, and two additional traffic count locations will be required on the new highway.

6.4.7 Summary of Residual Environmental Effects Assessment

The purpose of the Project is to construct a four lane divided controlled access Highway 104 from west of the Addington Forks Road intersection to east of Taylor Road to replace the uncontrolled access section of two lane highway. The removal of through traffic, as well as a considerable amount of local traffic, will improve ease and safety of access to residential and commercial driveways on the existing road. The new Highway 104 will improve the safety, convenience, economy and efficiency of travel for both the traffic diverted to the new highway and the residual traffic on the existing road. Due to the relative location of the existing Highway 104 and adherence to the current edition of the Nova Scotia Temporary Workplace Traffic Control Manual, no significant adverse residual effects on transportation infrastructure from Project construction are likely. Operation of the proposed highway will fulfill the purpose of the Project and will therefore have a positive effect on transportation infrastructure. Tables 6.28 and 6.29 summarise the residual environmental effects assessment for transportation infrastructure.

Table 6.28 Residual Environmental Effects Assessment Matrix Transportation Infrastructure (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Survey and Design	• Survey crews working on or near existing roads may affect traffic flow at areas where the proposed alignment crosses or joins existing roads (A)	• Adherence to *Nova Scotia Temporary Workplace Traffic Control Manual*	1	4	2 / 1	R	2	N	3
Grading	• Properties will be severed (A) • Kell and Cunningham Roads will be severed (A) • Construction traffic will use some area roads (A) • Construction activities will affect traffic flow at areas where the proposed alignment crosses or joins existing roads (A)	• Alignment location and access roads will minimize impacts to severed properties • Kell and Cunningham Roads traffic volumes are low and a convenient service road to Trunk 7 will be provided • Adherence to *Nova Scotia Temporary Workplace Traffic Control Manual*	1	4	3 / 1	R	2	N	3
Construction of Overpasses / Underpasses / Interchanges	• Construction activities will affect traffic flow at areas adjacent to each site (A) • Temporary short detours will be required (A)	• Adherence to the *Nova Scotia Temporary Workplace Traffic Control Manual*	2	2	2 / 1	R	2	N	3

Table 6.28 Residual Environmental Effects Assessment Matrix Transportation Infrastructure (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Paving	• Some construction traffic will occur on area roads (A) • Traffic flow at west and east ends of the new highway will be affected as connections to the existing highway are completed (A)	• Locating paving batch plants adjacent to the new alignment • Adherence to Nova Scotia *Temporary Workplace Traffic Control Manual*	1	3	2 / 1	R	2	N	3

KEY

Magnitude: 1 = Low *i.e.*, temporary reduction in level of performance; 2 = Medium *i.e.*, temporary alteration of travel patterns; 3 = High *i.e.*, permanent change in travel patterns

Geographic Extent: 1 = <500 m^2; 2 = 500 m^2 -1 km^2; 3 = 1-10 km^2; 4 = 11-100 km^2; 5 = 101-1000 km^2; 6 = >1000 km^2

Duration: 1 = < 1 month; 2 = 1-12 months; 3 = 13-36 months; 4 = 37-72 months; 5 = > 72 months

Frequency: 1 = < 11 events/year; 2 = 11-50 events/year; 3 = 51-100 events/year; 4 = 101-200 events/year; 5 = >200events/year; 6 = continuous

Reversibility: R = Reversible; I = Irreversible

Ecological/Socio-cultural and Economic Context: 1 = Existing transportation infrastructure provides for safe and efficient travel; 2 = Existing transportation infrastructure is ineffective, below standards; 3 = Existing transportation infrastructure shows evidence of unsafe transportation conditions.

Residual Environmental Effect Rating: S = Significant Adverse Environmental Effect; N = Non-significant Adverse Environmental Effect; P = Positive Environmental Effect

Confidence: 1 = Low level of Confidence; 2 = Medium level of Confidence; 3 = High level of Confidence

Table 6.29 Residual Environmental Effects Assessment Matrix
Transportation Infrastructure (Operation and Maintenance)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Significance Criteria for Environmental Effects					Residual Environmental Effects Rating	Level of Confidence
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Social-cultural and Economic Context		
Traffic Activity	• Diversion of through traffic from existing Highway 104 (P) • Diversion of some local traffic from existing Highway 104 (P) • Potential reduced traffic speeds on existing Highway 104 (P) • Improved ease and safety of access to properties on existing Highway 104 (P)	• No mitigation proposed	3	4	5 / 6	R	2	P	3

Refer to Table 6.28 for Key

7.0 MALFUNCTIONS AND ACCIDENTAL EVENTS

All necessary precautions will be taken to prevent the occurrence of malfunctions and accidental events that may occur during the life of the Project and minimize any environmental effects should they occur. Accidental events with the greatest potential for environmental effects include: spills of hydrocarbons or other hazardous materials; failure of erosion and sediment control measure; fires; and vehicular collisions. It is difficult to predict the precise nature and severity of these events. However, the probability of serious accidental events or those causing significant adverse environmental effects is low, particularly when construction and operation procedures incorporate contingency and emergency response planning. Construction and operation procedures will be conducted in accordance with relevant regulations, guidelines and accepted industry procedure. Accidental events related to effects of the environment on the Project are discussed in Section 9.

Spills

Spills of petroleum, oils, or lubricants (POLs) may occur during construction during refuelling of machinery or through breaks in hydraulic lines. These spills are usually highly localized and easily cleaned up by onsite crews using standard equipment. In the unlikely event of a large spill, soil, groundwater, and surface water contamination may occur, thereby potentially adversely affecting the quality of groundwater, fish and fish habitat, and wetland habitat, and resulting in the ingestion/uptake of contaminants by wildlife. Depending on the nature of the spill, it could also potentially affect residential, commercial, agricultural, and other land uses.

The EPP will contain best management procedures to minimize the likelihood of a spill and will contain instructions for crew training and orientation in spill prevention and management. POLs and other hazardous materials will be handled in accordance with applicable regulations and procedures as noted in the EPP. Construction equipment will be frequently inspected to detect possible fuel and hydraulic system leaks. Any leaks will be repaired immediately. Refuelling and equipment maintenance will be conducted at designated sites, away from residential and known cultural or heritage properties, and not within 30 m of a wetland or watercourse. The Project EPP will also contain a Spill Contingency Plan for the Project.

In the unlikely event of larger contaminant spills (*i.e.*, tanker accidents during highway operation), local and provincial emergency response procedures will be invoked to minimize impacts. It is noted that a site specific contingency plan will be in place to address such potential spills in the area of the Lower South River Wellfield protection zone (C) which encompasses a portion of the proposed alignment near the Taylor Road. Emergency response and contingency planning are accepted and effective means to limit the severity of accidental effects. These plans and procedures will be implemented through NSTPW's EPP and supported through training programs.

Significant adverse effects on any VECs or VSCs due to accidental spills are not considered likely.

Erosion and Sediment Control Failure

A potential exists for failure of erosion and sediment control structures due to precipitation events. Such a failure could result in the release of a large quantity of silt-laden runoff to receiving watercourses with adverse effects on fish and fish habitat. Erosion and sediment control measures will be implemented according to provincial guidelines (NSDOE 1988; NSTPW 1997 and revisions) and the Project EPP. Measures will be monitored by an environmental inspector, particularly after a heavy precipitation event or snow melt. Remedial action will be rapidly taken as necessary. In the event of a failure, Project construction will be shut down until controls are restored. An erosion and sediment control failure leading to a significant adverse effect on any VECs or VSCs is considered unlikely.

Fires

Fires may result in habitat loss, sensory disturbance, direct mortality to wildlife, loss or damage of property, and loss or damage to archaeological and heritage resources. Material management and operational procedures will reduce the frequency and extent of accidental fires related to the Project. Burning on the RoW will not be permitted. In the unlikely event of a fire, local emergency response and fire fighting capability will be able to reduce the severity and extent of damage. A fire prevention procedure will be included in the EPP to reduce the potential for fires along with training and orientation information for work crews. Significant adverse effects on any VECs or VSCs due to fires is considered unlikely.

Vehicular Collisions

Between 50 and 80 % of the traffic on the existing Highway 104 will likely divert to the new highway. While traffic collisions are inevitable, the new Highway 104 is expected to have a significantly improved collision rate compared with the existing Highway 104. Since this will be a new controlled access four lane divided highway with a wide median, collision rates are expected to be considerably lower than those on the existing two lane highway without access control. Diversion of through traffic, as well as part of the local traffic, to the new Highway 104, will improve the ease and safety of access for the remaining local traffic using the numerous road and driveway entrances throughout the study area. Public concerns for safety will be further reduced since most of the heavy trucks will divert to the new highway.

Any construction project that affects public highways has the potential for transportation related malfunctions and collisions. However, the following features of the Project will minimize the number, severity and effects of malfunctions and accidents in the study area:

- the opposing roadways of the new highway will be separated by a wide median;
- all entrances, exits and crossing of the new highway will be by interchanges, overpasses or underpasses;
- the horizontal and vertical alignments will be designed and constructed in accordance with current freeway design guidelines;
- the cross section of the new alignment will provide flat slopes and will minimize the number of roadside obstructions;
- traffic volumes on the existing roadway will be reduced considerably;
- the close proximity of a continuous parallel road (the existing Highway 104) and strategically located interchanges will reduce response times by emergency vehicles.

Malfunctions and collisions are not expected to have a significant impact on Transportation Infrastructure.

Summary

In summary, with adherence to best management practices, including adherence to the Project EPP and, if necessary, implementation of NSTPW's emergency response and contingency procedures, opportunities for malfunctions or accidental events as a result of this Project are minimized; in the event of occurrence, they are not likely to have significant adverse environmental effects.

8.0 CUMULATIVE EFFECTS ASSESSMENT

8.1 Methodology and Approach

Subsection 16(1)(a) of the *CEAA* requires that every assessment of a project conducted pursuant to *CEAA* include an assessment of the "cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out". Specific guidance related the assessment of cumulative environmental effects is provided by the Canadian Environmental Assessment Agency (CEA Agency) (1994, 1999a, 1999b). The methodology for the cumulative effects assessment is very similar to that adopted for the environmental effects assessment as described in Section 4 and is integrated with that assessment.

The approach to the environmental assessment for the Project integrated cumulative effects assessment in several ways. In particular, the effects of past and present activities with the potential to interact cumulatively with VECs and VSCs have been considered in the review of existing (*i.e.*, baseline) conditions. Where possible and pratical, existing environmental effects are attributed in the existing environment sections to particular projects and activities (*e.g.*, other linear developments, forestry activities) to identify causes of these past and present effects. However, consideration also needs to be given to the cumulative environmental effects resulting from interactions among the environmental effects of the proposed project with those of likely *future* projects and activities (refer to Section 8.1.2). Potential cumulative effects from past, present and likely future projects and activities are considered and integrated into the overall residual effects summary and conclusions (Section 12).

Mitigation and monitoring requirements related to other projects and activities are often outside of the proponent's control and responsibility. However, there often exists an opportunity for the proponent to participate in regional planning and monitoring efforts where cumulative effects are identified in order to help manage these regional effects to the extent that there is shared responsibility. General compliance with all pertinent regulations and guidelines by all proponents (*i.e.*, *Wildlife Habitat and Watercourses Protection Regulations*) will also assist with regional environmental management and education of cumulative effects.

8.2 Scoping of Other Projects and Activities and Potential Interactions

A critical step in the cumulative environmental assessment is determining what other projects or activities are to be considered. Relevant guidance related to this determination is provided by the CEA Agency (1994, 1999a, 1999b). Also, it is helpful to consider the clarification provided by the Joint Review Panel for the Express Pipeline Project in Alberta (NEB and the CEA Agency 1996). Following an analysis of subsection 16(1)(a) of *CEAA*, the Joint Review Panel determined that certain requirements must be met for the Panel to consider cumulative environmental effects:

- there must be an environmental effect of the project being proposed;
- that environmental effect must be demonstrated to operate cumulatively with the environmental effects from other projects or activities; and
- it must be known that the other projects or activities have been, or will be, carried out and are not hypothetical.

Furthermore, the Joint Review Panel indicated that it is an additional requirement that the cumulative environmental effect is *likely* to occur; that is, there must be some *probability*, rather than a mere possibility, that the cumulative environmental effect will occur. These criteria were used to guide the assessment of cumulative environmental effects of this Project.

In the early stages of the assessment, a scoping exercise was conducted to identify other past, present, and future projects and activities, the effects of which may interact cumulatively with those of the Project (Table 8.1). This assessment adopts the CEA Agency's current position of including 'certain' and 'reasonably foreseeable' projects in the consideration of cumulative environmental effects (CEA Agency 1999b). 'Certain' future projects and activities (*i.e.*, those that will be carried out) are assumed to include any that have already been approved by regulatory authorities or that are currently in a regulatory approvals process. 'Reasonably foreseeable' future projects and activities are assumed to include any that have been publicly announced by their proponents.

This scoping for cumulative environmental effects was included as part of the overall environmental assessment issues scoping exercise and therefore involved: consultations with local and regulatory authorities; review of previous Project-related documents and other relevant literature; field observations; and professional judgement.

Table 8.1 Summary of Potential Cumulative Interactions Between the Highway 104 Project and Other Projects and Activities on VECs

Project Activities	Air Quality	Groundwater Resources	Fish and Fish Habitat	Wetlands	Rare Herpetiles	Rare Mammals and Critical Habitat	Rare and Sensitive Birds	Rare Plants and Plant Communities	Potential Effects
Forest harvesting	✓		✓	✓	✓	✓	✓	✓	Destabilisation of terrain (erosion); sedimentation of watercourses; dust generation; habitat alteration and fragmentation; sensory disturbance to wildlife
Off-road traffic (ATVs)	✓		✓	✓	✓	✓	✓	✓	Destabilisation of terrain (erosion); sedimentation of watercourses; dust generation; sensory disturbance to wildlife.
Agriculture		✓	✓	✓	✓	✓	✓	✓	Habitat alteration and fragmentation; sensory disturbance to wildlife; erosion; sedimentation of watercourses; eutrophication of watercourses; contamination of soils and watercourses by pesticides.
Proposed Residential Subdivision Development near the RoW	✓	✓	✓	✓	✓	✓	✓	✓	Habitat alteration and fragmentation; sensory disturbance of wildlife; erosion; sedimentation of watercourses; eutrophication of watercourses; alteration of hydrology

Table 8.1 Summary of Potential Cumulative Interactions Between the Highway 104 Project and Other Projects and Activities on VECs

Project Activities	Air Quality	Groundwater Resources	Fish and Fish Habitat	Wetlands	Rare Herpetiles	Rare Mammals and Critical Habitat	Rare and Sensitive Birds	Rare Plants and Plant Communities	Potential Effects
Highway 104 New Glasgow to Sutherlands River			✓	✓	✓	✓	✓	✓	Potential cumulative effects from habitat alteration and fragmentation; sensory disturbance to wildlife; erosion and sedimentation; and dust generation. The effects from each Project are limited in space and time such that cumulative effects on these VECs are likely minimal.

Table 8.2 Summary of Potential Cumulative Interactions Between the Highway 104 Project and Other Projects and Activities on VSCs

Project Activities	Local Economy	Land Use	Transportation	Archaeological and Heritage Resources	Potential Effects
Forest harvesting		✓		✓	Noise disturbance to residential land use; woods roads provide increased access to remote areas
Off-road traffic (ATVs)		✓		✓	Noise disturbance; provides increased access to remote areas, possible trespassing onto private lands; increased access and potential vandalism to archaeological and heritage resources
Agriculture	✓				Provides increased access to remote agricultural areas; improved access to market
Proposed Residential Subdivision Development near or along the RoW	✓	✓			Noise disturbance to residential land use; improved accessibility to residential lands will also have an affect on land values during the land acquisition negotiation stage for subdivision plans along the RoW
Proposed amalgamation of the Town and County of Antigonish	✓				Positive and negative impacts on commercial establishments; distribution of potential benefits may be more equitable between Town and Country
Highway 104 New Glasgow to Sutherlands River	✓		✓	✓	Effects on local economy related to tourism travel; improvements to transportation infrastructure in the area; temporary and permanent loss of access to lands used for traditional purposes by Mi'kmaq people.

8.3 Cumulative Effects Analysis

Tables 8.1 and 8.2 provide an overview of the potential effects that other projects and activities may have on the VECs/VSCs selected for this assessment. In some cases, evidence of these effects has already been observed during the collection of baseline information for these VECs/VSCs (*e.g.*, effects of past forestry operations on fish and fish habitat).

Forestry and agricultural activities are currently occurring in study area, have occurred in the past, and are likely to continue in the future after the Project is constructed and is in operation. Potential cumulative effects on VECs associated with forestry activities and the Project include: destabilisation of terrain (erosion); sedimentation of watercourses; dust generation; habitat alteration and fragmentation; and sensory disturbance to wildlife. As indicated in Section 5.3, many of the smaller watercourses in the area showed signs of heavy siltation potentially attributable to forestry activities in the study area.

The new *Wildlife Habitat and Watercourses Protection Regulations*, which came into force January 14, 2002, provide for the protection of water quality, biodiversity and wildlife habitat. These regulations were derived from the NSDNR Forest/Wildlife Guidelines and Standards of 1989 and now make guidelines for forestry operations mandatory on all lands. As NSDNR works with industry and landowners to help promote understanding of and compliance with these regulations, adverse effects on wildlife, habitat and water quality are expected to diminish. Assuming effective implementation of Project erosion and sediment control measures, no significant cumulative effects on fish habitat are considered likely. Standard erosion and sediment controls and proper culvert design on other highway projects (*e.g.*, Highway 104, New Glasgow to Sutherlands River) will reduce the potential for cumulative effects on regional fish and fish habitat. In general, cumulative effects on watercourses and wetlands with respect to other linear developments is limited by spatial separation (*i.e.*, separate watersheds).

With respect to habitat loss and fragmentation, the study area has already been subjected to habitat fragmentation as a result of forest harvesting activity, agricultural activity, housing developments and linear developments including roads (*i.e.*, twinning of Highway 104, New Glasgow to Sutherlands River) and electrical transmission lines. Approximately 47 % of the proposed RoW passes through disturbed early successional habitats such as clear-cuts, shrub thickets and regenerating forest. Another 24 % of the RoW runs through areas affected by agricultural or residential land use. In instances where relatively undisturbed habitat must be used for highway RoW development, the RoW may run along side the edge of existing disturbed or settled areas, to the extent practical, in order to minimize the number of habitat fragments and habitat edge created by construction. The use of wildlife corridors, where possible, will also help to mitigate effects of habitat fragmentation and prevent isolation of wildlife populations. Regulatory protection of wetlands, including required mitigative measures and habitat compensation, will reduce the potential for cumulative effects on wetland and habitat, including habitat for birds. There is not likely to be any significant adverse cumulative effects on rare herpetiles, rare and sensitive birds, or rare mammals as a result of habitat fragmentation.

Several housing developments are planned for the area and it is expected that the new highway will make previously inaccessible areas available for development. These projects can potentially result in a number of adverse environmental effects including loss of natural habitat, sensory disturbance of wildlife, increased predation pressure on wildlife species due to the presence of cats and dogs in the area, erosion, sedimentation, alteration of the local hydrologic regime, and introduction of contaminants such as pesticides and fertilizers. These types of developments (*e.g.*, subdivisions) generally not subject to environmental approval other than sewer and water services. While habitat will be lost through clearing, standard mitigative measures (*e.g.*, erosion and sediment control) and regulatory requirements regarding working in proximity to watercourses will reduce the potential for cumulative effects with the Project to insignificant levels.

Some evidence of adverse effects associated with off-road traffic (*i.e.*, ATVs) has been observed along the proposed RoW. ATV riders use some of the woods roads along the route as travel corridors as well as a short section of the existing highway RoW near 0 + 700. The extent of ATV use along the route is relatively low compared to other areas in the province probably as a result of the limited number of access points for ATVs and the general lack of woods roads in the area. The Project may increase the amount of ATV traffic in the area. The cleared RoW could be used to access other woods roads and trails where they are intercepted by the new highway. The potential adverse effects of increased ATV access is not expected to be significant.

Mitigative measures proposed in this document will help to minimize potential adverse cumulative effects on VECs that may be currently affected by habitat fragmentation and sensory disturbance associated with forestry and off-road traffic activities, agriculture, and new subdivisions (*e.g.*, wetlands, rare herpetiles, rare and sensitive birds, rare mammals and critical habitat, and rare plants and plant communities). Watercourse crossings for the Project will be constructed in accordance with the applicable standards to minimize erosion and sedimentation, and disturbance to fish species as well as other mitigative measures specified in this document. The installation of new culverts and/or upgrading existing culverts may improve the current watercourse crossing conditions.

No significant cumulative effects on air quality are anticipated as a result of the Project since the air quality in the area is expected to be good and air emissions (exhaust) from construction and operational vehicles are not predicted to be substantial. In general, the Project will not cause additional traffic to travel through the study area. Dust emissions from Project construction activity will be localized and short-term, and are not expected to interact cumulative with dust generated by forestry activities, ATV traffic and other regional construction projects. There are therefore not likely to be any significant adverse cumulative environmental effects on air quality.

The Project activities are not anticipated to cumulatively interact with other projects to significantly affect groundwater resources.

With respect to cumulative effects on VSCs, the main issue is related to improved access to relatively inaccessible areas. Although there currently exist several woods roads and trails providing limited access throughout relatively undisturbed areas east of the proposed RoW, the highway will likely enhance access opportunities. This may result in increased trespassing on private lands and potential disturbance to land uses. However, access to these areas is only 'enhanced' by the Project as various trails currently extend to throughout these areas. Since trespassing and vandalism have not been identified as significant issues in the study area, it is not likely that the enhanced access provided by the Project will result in significant adverse cumulative effects.

Antigonish has a strong agricultural economy, primarily dairy production. Some studies indicate that nearby highways have effects on the growth and productive capacities of animals, the extent of which has not been fully ascertained. Existing and future animal production near the highway and development of other required highways, may therefore interact cumulatively with the planned highway development. This negative effect is, however, insignificant. Positive cumulative effects include improved access to farms and enhanced access to markets.

The Municipality of the County of Antigonish has received several residential development plans from owners of private properties along or adjacent to the proposed RoW. This interest in development will be facilitated, in general, by development of the new highway, creating cumulative effects on land use (*i.e.*, increased residential development and land value) in the study area. These effects will generally be positive for the VSCs Land Use and Local Economy.

There is an on-going discussion between political leaders and interest groups of amalgamating the Town and County of Antigonish. The amalgamation will result in just one local government for Antigonish. The new highway RoW is expected to cause commercial developments to move to areas within the jurisdiction of the County while there may be relatively greater adverse effects on commercial establishments situated within the Town. These effects may be translated to more fiscal revenue from commercial establishments for the County and less for the Town. The amalgamation therefore, if carried out could, in effect, distribute the potential economic benefits from highway development more equitably within the expanded municipal district.

Concerns have been raised to TPW that without adequate signage at Sutherlands River, the coastal route to Antigonish (referred to by some as a "mini-Cabot Trail") may be overlooked by travellers. In this case, the potential adverse effect of the Project on the local economy may be compounded by the New Glasgow to Sutherlands River highway upgrade as travellers will be offered a higher travel speed alternative over a larger geographical area, bypassing the local Town. It is believed, however, that adequate signage at Sutherlands River would mitigate this effect to non-significant levels.

Mi'kmaq land and resource use, may experience adverse cumulative effects as a result of multiple projects along Highway 104 . As indicated in the Mi'kmaw Knowledge Study (Appendix K), there are several areas along both alignments that support current Mi'kmaq land and resource uses and, in particular, several areas containing plants of significance to Mi'kmaq. However, as the Study indicates, these cumulative effects are not likely to be significant since these resource areas are not limited to lands within the RoWs.

8.4 Summary

With the implementation of the mitigative measures specified in this document, and adherence to applicable legislation and guidelines (refer to Section 3.3 for an overview), there are not likely to be any significant adverse cumulative effects associated with this Project. There is, in fact, predicted to be a positive cumulative effect on transportation infrastructure, land use, and the local economy.

9.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The definition of environmental effects under Section 2(1) of the *CEAA* includes "any change to the project that may be caused by the environment". Climate and weather conditions including precipitation and wind statistics for the area are provided below to help provide context for the analysis of environmental effects on the Project which follows.

9.1 Climate and Weather Conditions

Climate normals for the study area are based on data collected by Meteorological Service of Canada (MSC) weather stations located at Collegeville, Nova Scotia (Lat. 45° 28′N Lon. 62° 1′W) and Eddy Point (Lat. 45° 31′N Lon. 61° 15′ W). These data were taken from the Canadian Climate Normals (1971-2000) for Collegeville and Canadian Climate Normals (1951-1980) for Eddy Point. The station at Eddy Point (no longer in service) monitored wind conditions, an aspect not measured at Collegeville.

9.1.1 General Climate and Weather Patterns

The Project area, and Nova Scotia in general, has good air quality due to the relatively small population and small industrial base (NSDOE 1994). Climatic conditions provide good dispersion of air contaminants. Occasionally, however, long-range transport of air masses from central Canada or the eastern seaboard may transport contaminants into the area, causing poorer air quality.

On a global scale, the Atlantic Region lies within the zone of prevailing westerly winds. This zone is characterized by the passage of a series of high and low pressure systems. Paths taken by these systems are further influenced by ocean currents and continental topography. Cyclonic passages (low pressure systems moving through an area) may track across the continent or up the eastern seaboard. Typical cyclonic passages are marked by the onset of wind from an easterly direction, thickening cloud, and a gradual fall in pressure. Strong north-easterly winds and heavy precipitation are familiar accompaniments to these storms. Should the storm centre pass to the south, the wind direction will change in a counterclockwise manner and precipitation may persist for several days. If the low pressure centre tracks to the north of the observing station, the wind direction usually veers (changes in a clockwise manner). The cyclonic passages typically last from a few days to a week.

During the summer, persistent high pressure systems off Bermuda result in prolonged periods of stagnant weather with warm temperatures and light winds from the south. These events promote the movement of air pollutants from the eastern seaboard to the Project area. There may also be a subsidence inversion (persistent meteorological conditions limiting atmospheric dispersion) accompanying the high pressure system that further enhances the potential for air quality to deteriorate.

This is the situation that generally accompanies the days with perceptible pollutant haze and hot stagnant periods in the summer.

During periods of low wind speed, particularly in the summer months, the occurrence of sea-breezes and land-breezes are evident along the coastline and several kilometres inland. In the daytime, strong solar insolation causes a warming of the land and the rising air is replaced by air moving in from the offshore. During the night, the reverse may occur, but the cold water temperatures tend to reduce the possibility of the land-breezes.

Hurricanes can develop in the tropics and typically move up the eastern seaboard. These storms are significantly downgraded as they encounter the colder waters off the northeast United States and Canada. Usually, by the time a hurricane reaches the Project area, it will have weakened into a tropical storm or an intense low pressure system with strong winds and heavy rains. Hurricanes may also cause heavy swells and high waves along the coast. Although the hurricane season starts June 1st, the peak time for these storms is between September and October.

9.1.2 Temperature Normals and Extremes

Temperature Normals for Collegeville are shown in Table 9.1. The annual temperature range for Collegeville is normally between +18°C and -7°C. However, extreme temperatures of +38°C in summer and -37°C in winter have been recorded.

Table 9.1 Temperature Normals and Extremes for Collegeville, Nova Scotia

Month	Daily Maximum (°C)	Daily Minimum (°C)	Daily Mean (°C)	Extreme Maximum (°C)	Extreme Minimum (°C)
Jan	-1.5	-11.6	-6.6	17.0	-34.4
Feb	-1.6	-11.6	-6.5	15.5	-37.2
Mar	2.6	-6.8	-2.1	23.0	-30.6
Apr	7.9	-1.4	3.3	27.8	-23.3
May	15.0	3.4	9.2	33.9	-8.0
Jun	20.5	8.2	14.4	35.0	-4.4
Jul	24.0	12.4	18.2	36.1	-1.1
Aug	23.5	12.3	17.9	38.3	-0.6
Sep	18.9	8.0	13.5	34.4	-6.7
Oct	12.7	3.1	8.0	28.3	-10.0
Nov	6.8	-1.0	2.9	25.6	-18.9
Dec	1.2	-7.5	-3.1	20.6	-30.5
Year	**10.8**	**0.6**	**5.8**	--	--

Source: Canadian Climate Normals 1971-2000 (Environment Canada 2002)

9.1.3 Precipitation Normals and Extremes

Precipitation measured at Collegeville is presented in Table 9.2. Although rain may occur in any month of the year, the rainfall in the area is highest during fall. Snow and freezing precipitation can occur between October and May, with the largest amounts falling between December and March.

Table 9.2 Precipitation Normals and Extremes for Collegeville, Nova Scotia

Month	Mean Rainfall (mm)	Mean Snowfall (mm)	Total Precipitation (mm)	Extreme Daily Rainfall (mm)	Extreme Daily Snowfall (mm)	Extreme Daily Precipitation (mm)
Jan	78.3	47.2	125.5	87.6	38.1	87.6
Feb	51.0	45.3	96.3	56.4	40.6	61.0
Mar	80.1	36.2	116.3	78.7	45.7	78.7
Apr	81.2	17.7	99	53.3	38.1	53.3
May	106.5	2.5	109.1	54.6	25.4	54.6
Jun	99.7	0.0	99.7	198.1	0.0	198.1
Jul	89.8	0.0	89.8	104.1	0.0	104.1
Aug	102.1	0.0	102.1	203.2	0.0	203.2
Sep	112.2	0.0	112.2	104.1	0.0	104.1
Oct	145.0	1.3	146.3	115.1	17.8	115.1
Nov	133.3	12.2	145.5	98.6	34.3	98.6
Dec	96.6	46.2	142.8	100.2	40.6	100.2
Year	**1175.7**	**208.5**	**1384.3**	--	--	--

Source: Canadian Climate Normals 1971-2000 (Environment Canada 2002)

Total precipitation is rainfall plus the water equivalent of the snowfall and all other forms of frozen precipitation. Normally, the monthly precipitation amounts for Collegeville ranges from 90 mm (July) to 146 mm (October).

9.1.4 Wind Normals and Extremes

Wind statistics are not available at the Collegeville station. Statistics (Canadian Climate Normals 1951-1980) from a past monitoring station at Eddy Point (Lat. 45° 31′N Lon. 61° 15′ W) are provided. The prevailing winds in the area are westerly to northwesterly in the colder months and south to southwesterly in the warmer months.

The average and extreme wind speed and direction values are shown in Table 9.3.

Table 9.3 Wind Statistics from Eddy Point

Month	Average speed (km/h)	Most Frequent Direction	Extreme Hourly Speed (km/h)	Direction	Extreme Gust Speed (km/h)	Direct ion
Jan	19.5	W	70	SSE	97	ENE
Feb	19.4	NW	64	NNW	106	WNW
Mar	19.1	NW	77	W	130	SW
Apr	16.6	NW	71	E	93	E
May	15.6	NW	55	NE	85	S
Jun	14.1	S	64	SVL	89	NNE
Jul	13.2	Calm	60	S	87	S
Aug	12.7	Calm	44	SSW	65	NW
Sep	14.7	S	50	WNW	89	W
Oct	16.6	W	64	S	137	S
Nov	17.9	W	61	W	91	NW
Dec	19.2	W	69	SSE	93	S
Year	**16.6**	**NW**	**77**	**W**	**137**	**S**

Notes: Wind direction refers to point of wind origin. SVL=several directions
Source: Atmospheric Environment Branch, Canadian Climate Normals: 1951- 1980

In winter, many low-pressure systems pass through south of the region, while in summer they tend to pass north of the region. Average wind speeds vary from 12 to 15 kilometres per hour (km/h) in summer to near 20 km/h in winter.

9.2 Effects of the Environment on the Project

There is a number of planning, design and construction strategies intended at minimizing the potential environmental effects of the environment on the Project so that the risk of serious damage to the Project or interruption of service can be reduced to acceptable levels. Mitigation measures include, among other things, designing structures to relevant codes, and scheduling of activities to allow for weather interruptions. All of the construction activities will be taking place out-of-doors and thus weather has been factored into the design of the Project.

9.2.1 Climate Change

On a national basis, Canada shows a warming and cooling pattern with a higher overall warming trend of approximately 1.1 °C since 1895. The Atlantic Region, however, shows a warming trend from 1895 which peaked in the mid 1950s followed by a cooling trend in the 1990s. The overall warming trend of 0.4°C in Atlantic Canada since 1895 is not statistically significant. With respect to precipitation, the Atlantic Region shows an overall increasing trend in precipitation since 1948, with an increasing trend in the number of daily precipitation events above 20 mm and a very slightly increasing trend in the number of daily snowfall events above 15 cm (Lewis 1997). Appendix B contains additional information on climate changes, particularly as it may affect precipitation and hydrology.

Effects of climate change on the Project are not considered to be particularly relevant due to the time frame associated with climate change relative to the proposed time frame for Project construction. Extreme events, including increased precipitation are considered in Project design and mitigation during operations (see below).

9.2.2 Sea Level Rise

Relative sea level has been changing systematically throughout southeastern Canada for thousands of years, due to the interplay between crustal loading (by ice or water) and the level of the global ocean (Forbes *et al.* 1997). Tide-gauge data from Halifax indicate a rising trend of 0.36 m/century since 1920 (Shaw and Forbes 1999). It is estimated that as much as a third of this may be due to global rise in sea level (Grant 1975). Low lying coastal lands are subject to inundation under high tides and storm surges. The frequency of such flooding and the landward limits of flooding will increase with a rise in mean relative sea level. It is not likely that sea level rise will have an effect on the Project.

9.2.3 Extreme Precipitation

Extreme rain can result in work stoppages during construction and create difficult working conditions. Rain is an expected work hazard and the schedule allows for rain. In the event of extreme rain, the EPP will be designed to ensure that environmental loads (*e.g.,* sediment-laden water) are addressed appropriately and minimize sedimentation events. The EPP will also ensure that the integrity of the highway is not compromised. If unusual wet periods or excessive rain do occur, this can result in Project delays and an associated delay in completion and can result in additional capital cost. During the operational phase of the highway, extreme rain may limit visibility and can lead to hydroplaning conditions.

Excess water is addressed by the proper sloping off the highway to allow for run-off. Proper roadbed design prevents settlement and rutting which result in water pooling on the roadbed, potentially leading to hydroplaning. Water control off the highway is mitigated through ditching along and between the lanes.

Extreme snowfall can also affect winter construction or contribute to unusual flooding during snowmelt. Exceptional early snowfall could delay construction and result in additional work for snow clearing and removal. This could increase construction costs. Early snow cover can minimize or prevent ground freezing and this may affect winter construction intended at improving work progress and accessibility.

Ice and snow interferes with the operation of vehicles on the highway as it can cause slippery driving conditions and limit visibility. Ice and snow are controlled through snowplowing, and sand and salting of the roadways. Snow and ice can result in visibility issues. Under extreme conditions operation of the highway can be temporarily suspended at the discretion of RCMP and NSTPW officials.

Major cuts and fills in roadway construction can affect the deposition of snowfall, depending on micro-climate conditions. At present, there are eight areas along the alignment with significant cuts (>5 m) proposed. The approximate locations are: 4+240 (north end of Trunk 7); 5+900 (South of Willowdale Lane); 7+230; 7+770; 8+430; 9+620; 10+270 (South of MacEachern Loop) and; 11+670 (East of Dunns Loop).

NSTPW will undertake further study of the entire alignment with regard to snow deposition once detailed design of the highway is in progress. The final profile will be designed to reduce the possibility of obstructions to visibility or snow drifting. Once cross sections for the design are finalized, a section of roadway of similar profile and orientation to prevailing winds will be studied in combination with detailed storm data for the Antigonish area. The severity of effects from blowing/drifting snow will be estimated and mitigation determined. Mitigation measures, if necessary, may include cut/slope design, and aerodynamic barriers to decelerate the wind and cause the snow to accumulate away from the affected section of roadway.

9.2.4 Flooding

As discussed in Appendix B, ice or debris jam may endanger the stability of the roadway embankment. Unnamed watercourses at chainages 0+275, 2+240, 8+150 and 10+250, were identified as having potential for ice and debris jam, especially with additional flows from the highway. Watercourse crossing structures will be designed to allow the passage of ice and debris.

9.2.5 Fog

Reduced visibility due to dense fog is more prevalent in late spring and early summer, when warm moist air from the south flows over relatively cold coastal waters. The period from mid-spring to early summer is generally the foggiest time. By early fall, a combination of cooler, drier air and warmer ocean temperatures both contribute to a decrease in fog.

Bands of thick, cool fog lie off the coast, produced where the chilled air above the Labrador Current mixes with warm, moisture-laden air moving onshore from the Gulf Stream. With onshore winds these banks of fog move far inland. Sea fog often affects the headlands by day, moving inland and up the bays and inlets at night. At other times of the year fog is much more transient and local in nature (Environment Canada 2003).

Fog can occur at any location along the route under the right meteorological conditions. Under extreme conditions operation of the highway may be suspended, but this is highly unlikely for this portion of the route. Sheltered areas (e.g., cuts) are susceptible to early morning radiation fog under clear sky conditions where there is little air circulation. In general, the highway will discourage these conditions as the four-lane road construction will open areas and promote air mixing.

9.3 Summary

The Project will be designed to account for potential effects of the environment. No significant adverse effects on the Project are therefore predicted.

10.0 ENVIRONMENTAL MANAGEMENT AND MONITORING

10.1 Environmental Management

NSTPW is committed to the effective management of all Project activities potentially affecting the biophysical and socioeconomic environments. This commitment has been demonstrated during the Project planning phase through the completion of an environmental screening conducted by NSTPW, resulting in a route selection process geared toward minimization of adverse effects. NSTPW is also committed to effective implementation of all of the environmental design and mitigation measures specified previously in this document including other measures described in this section.

Environmental protection plans (EPP) and emergency response plans for the Project will be completed after environmental assessment approval, prior to construction. These plans will be submitted to NSEL for approval, which will involve circulation to Environment Canada, DFO and other regulatory agencies as required.

An EPP will contain general and specific mitigation measures for Project construction and operation, including measures specified in this document and applicable approval conditions. The EPP will combine generic protection measures applicable to all highway construction activities in the province with environmental protection measures specific to this Project (*e.g.*, site specific erosion control plans for the West River and South River crossing). In particular, areas of special environmental consideration (*e.g.*, South River and locations of rare and sensitive species) will be identified with specific protection measures included as appropriate. The EPP will also contain requirements for the contractor to complete a work progression schedule for approval by the NSTPW Project Engineer. Monitoring requirements, including, but not limited to, the rare plant monitoring at West River, and other follow-up plans (*e.g.*, wood turtle risk management plan) will also be included.

10.2 Emergency Response and Contingency Planning

Accidental events resulting in potential adverse environmental effects may occur during Project construction and operation (refer to Section 7.0). These events may include: spills of fuels and other hydrocarbons; fires; and vehicular accidents. It is difficult to accurately predict the precise nature, probability and severity of these events on the environment. Material management and operational procedures will reduce the frequency and extent of accidental events. Emergency response and contingency planning are accepted and effective means to limit the severity of effects.

NSTPW will have contingency plans in place to address these events as well as to address unlikely encounters with heritage resources, contaminated sites and acid producing bedrock.

10.3 Monitoring Programs

Different types of environmental monitoring occur at different phases of a Project and for different purposes. Once the specific alignment is fixed within the study area, pre-construction monitoring and survey activities will be implemented to establish baseline conditions for certain VECs/VSCs, as specified in this document or subsequently required under conditions of regulatory approval. Two other types of environmental monitoring, which are normally carried out during and after construction, are environmental compliance monitoring (ECM) and environmental effects monitoring (EEM). ECM involves monitoring of activities by regulatory authorities and NSTPW, to ensure compliance with all regulatory requirements and self-imposed environmental commitments. EEM is environmental monitoring which may be undertaken to assess the accuracy of impact predictions, and to evaluate the effectiveness and identify the need to alter or improve mitigative and compensatory measures.

10.3.1 Pre-Construction Monitoring

Pre-construction monitoring activities will, at a minimum, include a well water survey and a pre-blast survey. Other pre-construction monitoring, as specified in this document include pre-construction surveys for wood turtles on the West River (Section 5.4.6) and for rare plants, as a component of an intervale habitat enhancement program (Section 5.7.6).

Well Water Survey

Based on final project design, a well water survey will be developed to assess the quality and quantity of wells near proposed blasting operations if blasting is required and near areas of significant excavations. The number of wells to be sampled and sampling parameters will be determined by the blasting contractor. A well water survey protocol is included in Appendix G.

Pre-Blast Survey and Monitoring

Detailed design surveys will indicate where, if at all, blasting will be required. If blasting is conducted, a pre-blast survey of all properties that would potentially be affected by construction blasting will be performed. A pre-blast survey and monitoring program will be developed when design details, field conditions and the amount of bedrock that requires blasting is fully defined.

The area that would be affected by blasting operations depends largely upon the magnitude of blasts required to achieve the desired volume of cut in bedrock. The number of properties to be surveyed will be determined by the contractor.

For each residence and outbuilding to be inspected, external and internal conditions will be recorded. Landowners who will not permit examination of their properties will be asked to sign a waiver to this effect.

Monitoring of ground vibration with one or more seismographs and monitoring of air blast with a decibel meter will be carried out for each blast; refinements may have to be made to the charge weight when actual site specific vibration data becomes available.

In the event of blast danger claims, the construction contracts will stipulate that such claims be dealt with promptly. A telephone number to which claims and inquiries about the operations could be directed, will be made public by the contractor.

10.3.2 Environmental Compliance Monitoring

NSTPW will establish an ECM program to ensure that all regulatory requirements and commitments are being met. ECM can be divided into two elements: regulatory environmental surveillance; and self-regulatory environmental compliance monitoring. Regulatory environmental surveillance is carried out by regulatory authorities. Self-regulatory environmental compliance monitoring is that which NSTPW undertakes to monitor its own activities against internal and external environmental standards. Self-regulatory ECM overlaps with regulatory environmental surveillance where the external standards which are being monitored are regulatory in nature. However, self-regulatory ECM is a much broader concept and is an important tool for the implementation of mitigation, particularly where government regulations are vague or non-existent. Self-regulatory ECM can involve:

- monitoring of all environmentally-sensitive activities to ensure compliance with internal and external non-regulatory environmental standards;
- coordination of communication with regulatory authorities; and
- provision of on-site environmental advice to Project personnel.

The principle mechanism for ECM will be the EPP, which provides the practical framework for the implementation of the environmental requirements of the Project. The EPP will also provide a common reference document against which compliance can be judged by both regulatory authorities and NSTPW.

10.3.3 Environmental Effects Monitoring

EEM involves taking repetitive measurements of environmental variables over time to detect changes caused by external influences directly or indirectly attributable to a specific human activity or development. EEM is generally undertaken to:

- improve environmental understanding of cause and effect relationships;
- provide an early warning of undesirable change in the environment; and
- verify earlier predictions of impacts and effectiveness of mitigative measures.

The EEM program will be incorporated into the EPP developed by NSTPW and will be updated as required, as information regarding the predicted impacts and effectiveness of mitigative measures is collected.

Routine monitoring of dust is not anticipated. If required however, air sampling will be conducted in accordance with NSDEL and Environment Canada methodologies for High-Volume air sampling of TSP matter. Erosion and sediment control structures will be routinely inspected and maintained appropriately. Surface water quality, site and habitat restoration, and bank stability and protection will be monitored regularly during construction and thereafter until soils have been permanently stabilized. Where habitat restoration is undertaken, monitoring programs will be implemented. Archaeological monitoring at the South River crossing will be undertaken as necessary.

10.4 Compensation Programs

10.4.1 Compensation for Land Acquisition

NSTPW's land acquisition and compensation policy will generally follow the guidelines developed under the Nova Scotia *Expropriation Act*. Property expropriation under the *Act*, however, only occurs when negotiations between individual property owners and/or their legal representatives fail in reaching a fair and equitable settlement.

Once the final design and location of the proposed undertaking has been determined, the process of land acquisition begins. Normal practice is to determine the local market value in accordance with recognized real estate appraisal practices for properties directly impacted and those which may be injuriously affected as appropriate. Acquisition and Disposal Officers will contact property owners to negotiate a mutually acceptable settlement. If negotiations fail, the property is formally expropriated and the claim is scheduled to be heard by the provincial Expropriation Board.

There are a few additional actions which could assist in reducing some of the potential adverse impacts of relocation from these properties. These include landowner notification at the earliest possible time in the planning and design stages of the proposed alignment. Early property purchases are considered in cases where: the property may already be on the market; the majority of the property will be impacted by the alignment; and when NSTPW is fairly confident the alignment will be approved, requiring certain properties to be acquired. There are, however, risks associated with early property purchases. If properties are acquired too early, before Project approval, there is a risk that the environmental assessment, survey and detailed design may reveal issues previously unknown which may warrant changes to the Project, possibly changing the location of impacts and properties to be acquired.

10.4.2 Compensation for Lost Habitat

DFO has developed the *Policy for the Management of Fish Habitat* (1986) under the federal *Fisheries Act*, which applies to all Projects and activities in or near water that could alter, disrupt or destroy fish habitat by chemical, physical, or biological means (refer to Section 5.3). The guiding principle of this policy is to ensure no net loss of the productive capacity of fish habitat. All activities which have the potential to affect watercourses inhabited by fish must be approved in advance by NSDEL and DFO. NSTPW may be required to develop compensatory fish habitat if mitigative measures are not effective, resulting in a loss of the productive capacity of the habitat.

NSTPW will, in consultation with NSDNR and NSDEL, develop a wetland compensation plan to compensate for wetland lost in the area during Project construction. Wetland replacement, if required, would consist of creating wetland habitat capable of exceeding the wetland functions lost or reduced in the original wetland (refer to Section 5.8 and Appendix I).

11.0 PUBLIC INFORMATION PROGRAM

NSTPW began working with the Atlantic Expressway Committee (AEC), a broad based local interest group, in 1996 to identify an alignment and access locations that would meet the requirements of NSTPW the local community. NSTPW and AEC decided to bring alignment options before the community for discussion prior to the making any selections. A total of three open house public meetings were hosted by NSTPW. The initial meeting was held in May 1997 during the early planning stages of the Project to present local stakeholders and the general public with Project information and obtain feedback. At the second meeting in May 1998, three potential alignments were presented to the community to receive feedback from the public to be used in the alignment selection process. The third meeting, held in May 2001, presented the recommended alignment for the EA Registration document (NSTPW 2001a).

The initial open house, held at the Saint Francis Xavier University in May 1997, served to present the results of NSTPW's preliminary environmental screening and to solicit opinions related to the broad corridor and potential access locations being considered. This corridor incorporated ten exclusion zones identified through the completion of the screening. The corridor, between approximately 1 km and 3 km wide, extended west to east from approximately 1 km west of Addington Forks Road to just east of Taylor Road.

The public meeting was well attended with 339 recorded visitors and 102 questionnaires completed. Respondents who thought that the Project would impact their business or property identified the following concerns: potential impacts on business; increased traffic, noise and pollution; reduced safety for children; reduced access to the existing highway; impact to water supply; impacts, including devaluation, to residential, farming or woodlot properties; and loss of aesthetic value. Constraints identified at the open house included eagle and osprey nests along South and West Rivers and a cemetery near South River that was outside the corridor boundaries. The issues identified as important by the questionnaire were safety, economic, environmental and residential impacts, noise, traffic flow, social impacts, property values, pollution, aesthetics, farmland and cost. Benefits identified at the meeting included increased safety, improved traffic flow/access, less traffic and noise, and potential positive economic impacts/commercial development.

A second open house meeting was hosted by NSTPW and AEC in May 1998 at the St. Andrew Junior High School in Antigonish. There were three formal presentations by NSTPW and AEC made at different times throughout the day. The objective of this consultation was to provide information and afford members of the community the opportunity to provide input on the selection of the alignment and access options. Prior to the meeting, efforts were made to contact all landowners directly affected by any of the alignment options by either telephone or by mail to inform them of the potential impacts to their property and to give them the opportunity to provide input. Information flyers were sent to most homes and businesses in Antigonish County and advertisements were placed in the local paper. At the meeting, fact sheets describing the Project, including a small plan of the alignment options, were distributed and attendees were encouraged to complete questionnaires. Some 700 residents of the area registered their names in the guest book and 612 completed questionnaires. The questionnaire asked respondents to identify a preferred alignment, provide reasoning for their choice, to rank acceptability and identify the pros and cons of each of the alignment options, and to identify four preferred interchange locations. Subsequent analysis of the questionnaires identified the preferred alignment as the Red alignment and preferred access locations as Trunk 7 and Addington Forks overall with varied support for Church Street, Route 316 and Taylor Road, dependent on the route preference.

A debriefing of staff following the meeting and subsequent correspondence received by the NSTPW and the local newspaper indicated strong support for the Blue and Brown routes, conflicting with the survey analysis which identified the Red alignment as the preferred route. Further investigations including a safety review in 1999, a peer review in 2000 and an impact study on the proposed South River crossing in 2001 were completed and the Blue Route was selected based on a global evaluation of constraints.

A third public consultation session was held in May of 2001 to present the recommended alignment for the EA Registration. The final alignment proposed for EA registration of the Project was presented at a third open house meeting held in May 2001. Approximately 200 people attended this session with 27 completed comment sheets handed in. Analysis of the comment sheets revealed 52% of respondents supported the Project while 15% did not support the Project. Another 22% of respondents did not oppose the Project but had concerns over certain aspects of the proposed work.

In addition to alignment alternatives, other alternative means of carrying out the proposed Project may include buffer zones, alternative wetland and watercourse crossing methods/structures such as bridges, underpasses, and wildlife corridors (refer to Section 2.4.3). Specific alternatives and preferred options are discussed further in relevant sections in this report.

In November 2001, NSTPW registered the Project with NSDEL under the *Environment Act*. A newspaper notice was placed notifying the public of the registration document, along with proposed terms of reference for the environmental assessment; these were made available for public review. NSDEL considered comments received from the public on both the EA Registration and draft EA terms of reference during preparation of the final terms of reference.

Since the Project is considered a Class II Undertaking under the *Environmental Assessment Regulations*, the public will also have an opportunity to review this environmental assessment report and submit comments to NSDEL.

NSTPW is committed to an ongoing public involvement and information program to identify stakeholder issues and concerns. A CLC will be developed to act as a liaison between NSTPW and various stakeholders in the Project. Issues to be discussed may include Project information, conflict resolution, and input to monitoring and mitigation programs.

A dispute resolution policy will be established for addressing Project- related complaints and concerns that may be received from nearby landowners or stakeholders. The intent of the dispute resolution policy is to ensure that a structured system is established to enable NSTPW to fulfil the goal of effective and responsible communication with landowners and stakeholders.

12.0 SUMMARY AND CONCLUSIONS

This environmental assessment was conducted to identify potential environmental effects of development of the proposed Highway 104 at Antigonish. This assessment fulfills the requirements for a Class II Undertaking pursuant to the Nova Scotia *Environment Act* and *Environmental Assessment Regulations*. It also fulfills the requirements for a Screening under the *CEAA*. A preliminary environmental screening, functional analysis, and public consultation, have been completed by NSTPW as part of the preliminary planning for the Project. The Project has also undergone a detailed safety review, an independent peer review and a detailed assessment of environmental impacts at the proposed South River crossing.

This assessment considered both biophysical and socioeconomic issues. It focussed on issues of greatest concern, otherwise known as VECs and VSCs. The issues were identified through a scoping process subsequent to NSTPW's preliminary environmental screening. Each of the following eight VECs and four VSCs selected for this assessment were evaluated for potential Project-related effects.

VECs

- Atmospheric Resources
- Groundwater Resources
- Fish and Fish Habitat
- Rare Herpetiles
- Rare Mammals and Critical Habitat
- Rare and Sensitive Birds
- Rare Plants and Plant Communities
- Wetlands

VSCs

- Local Economy
- Land Use
- Archaeological and Heritage Resources
- Transportation Infrastructure

Mitigation and monitoring have been proposed to reduce or eliminate potentially adverse effects (refer to Table 12.1) for each VEC/VSC. The significance of residual environmental effects (*i.e.*, after mitigation has been applied) including cumulative effects was also predicted for each VEC/VSC.

In general, potential adverse environmental effects on these VECs/VSCs will be short term and/or highly localized and can be effectively mitigated through technically and economically feasible methods described in this report. Adverse residual effects therefore are predicted to be not significant for both construction and operation phases of the Project for all VECs and VSCs. Adherence to standard construction and operational procedures, the Project EPP, and contingency procedures will minimize the likelihood of malfunctions and accidental events. No significant adverse residual environmental effects are therefore predicted for any VEC/VSC with respect to malfunctions and accidental events.

Table 12.1 Summary of VEC/VSC Specific Mitigation and Monitoring Requirements

VEC/VSC	Mitigation	Follow-up and Monitoring
Atmospheric Resources	• Application of water and dust suppressant to control dust as required • Complaint resolution policy • Cleanup of mud and dirt from paved roadways • Noise controls and restricted working hours, especially at Sites 5 and 8	• Dust monitoring as required to respond to community concerns
Groundwater Resources	• Bedrock will be excavated by ripping where possible rather than blasting • Avoidance of blasting within 500 m of residential wells and Lower South River wellfield to the extent possible • Measures will be taken to minimize sedimentation and erosion potential • Pre-blast survey • Minimal exposure of slate bedrock or water table lowering • Remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed • Apply drainage and vibration controls	• Pre-construction well water survey and follow-up water level monitoring as required • Blast monitoring • Monitoring of dug wells during and following construction to ensure quality and quantity
Fish and Fish Habitat	• Schedule instream work between June 1 through September 30 • Adhere to the EPP • Establish a 75 m buffer zone to exclude grubbing and grading from watercourse areas until watercourse crossing structures are installed • Acid drainage risk testing during geotechnical program; application of management program if necessary • Adhere to DFO guidelines for blasting near watercourses (Wright and Hopky 1998) • Exclusion of fish from area during blasting • Acidic drainage management if necessary • Habitat restoration • Appropriate crossing method to minimize flow disruption • Culvert alignment and sizing to accommodate fish passage as per DFO guidelines • No application of herbicides: 1) within 30 m of any watercourse; 2) as prescribed on product label; and 3) within 60 m of a protected water supply. • Installation of permanent erosion and sediment control measures • Adhere to sediment and erosion control measures and vegetation management plans detailed in the EPP • Maintain vegetated buffer zone around watercourses	• Surface water quality monitoring during construction for total suspended solids and acid rock drainage as required • Follow-up inspections to evaluate site and habitat restoration, bank protection and stability, and to ensure culvert installation allows fish passage where required
Rare Herpetiles	• Conduct wood turtle presence/absence surveys • Construction worker training and wood turtle relocation • Consider design modifications to structures at Stream Crossing No. 11 (*e.g.*, open bottom culvert) at West River and at South River • Public awareness campaign to decrease turtle strikes on road, and removal of turtles from habitat	• Development of a wood turtle risk management program by NSTPW in coordination with NSDNR at the South River and the West River and its unnamed tributary at 8+150 (Stream Crossing No. 11)
Rare Mammals and Critical Habitat	• Minimize vegetation clearing as practical for RoW preparation • Consider longer bridge spans to preserve vegetative fringe for wildlife travel routes	• None required

Table 12.1 Summary of VEC/VSC Specific Mitigation and Monitoring Requirements

VEC/VSC	Mitigation	Follow-up and Monitoring
Rare and Sensitive Birds	• Schedule clearing, grubbing, and grading to avoid breeding seasons • Minimize the width of the cleared RoW • Establish 200 m radius buffer zones around Osprey nests near route within which no construction is permitted • Identify and mark minimum safe working area around bridge pier construction sites; approach roads to these sites will avoid habitat suitable for Nelson's Sharp-tailed Sparrow • Where feasible, do not mow cleared RoW between April 1 and August 1 to avoid destruction of the nests of ground nesting species such as Bobolink • Implement TPW's Integrated Roadside Vegetation Management program to reduce the necessity of mowing and brush cutting	• None required
Rare Plants	• Preferred mitigation to shift RoW to avoid rare or sensitive plants (shift RoW 125 m north at West River, 100 m south to avoid black ash at 12 + 700) is not feasible given presence of other constraints. • Alternative mitigation for West River: 1) Design bridge structure to minimize the amount of intervale habitat disturbed by the bridge; 2) Plan the bridge pier construction sites to minimize the amount of habitat disturbed; 3) Implement an intervale enhancement program to improve habitat quality and increase populations of sensitive species; 4) Direct bridge drainage away from areas where rare or uncommon species are present; 5) Minimize amount of brine and salt contaminated slush and snow thrown over side of bridge by snow plows and vehicles; 6) Identify the West River section where rare species occur as a salt sensitive area to be a candidate for pre-wetting and anti-icing agents to reduce exposure to salt laden runoff • Alternative mitigation for black ash is to plant black ash seedlings to replace the black ash lost to highway construction • Purple milkweed: do not clear the portion of Wetland 2 that is located within the RoW but outside of the footprint of the highway; do not mow or brush cut wetland habitat at Wetland 2 • Water loosestrife: carefully place and size culverts to ensure that the hydrology of Wetland 1 is not altered • Marsh mermaid-weed: infill only the amount of wetland habitat required to construct a safe roadbed; carefully place and size culverts to ensure that the hydrology of Wetland 1 is not altered • Minimize width of RoW to be cleared within mature climax and climax dominated forest	• Monitor abundance and distributions populations of rare and uncommon plant species at West River crossing site as part of intervale habitat enhancement program

Table 12.1 Summary of VEC/VSC Specific Mitigation and Monitoring Requirements

VEC/VSC	Mitigation	Follow-up and Monitoring
Wetlands	• Avoid wetland habitat wherever feasible • Where avoidance is not feasible, mitigate loss through Wetland Compensation Plan • Implement erosion and sediment controls to prevent sedimentation of wetlands • Design the highway and associated drainage system to avoid altering wetland hydrology • Consider type of structure at Wetland 11 to reduce the incidence of roadkill • Wetlands 1, 6, 11, and 12: salvage wetland soils from disturbed wetland habitat and incorporate into replacement wetland habitat to speed establishment of plant communities • Wetlands 1, 2, 6, 7, and 19: salvage wetland soils from disturbed wetland habitat and incorporate into replacement wetland habitat. Test salvaged soil to ensure that toxic concentrations contaminants will not be released when the soil is moved • Wetlands 1, 2, 10, 15, and 17: minimize the amount of wetland habitat affected by clearing, grubbing and infilling only the portion of the wetland required for construction of the roadbed • Wetland 21 (South River): design bridge structure to minimize amount of habitat affected; minimize infilling of flood plain; locate the bridge structure as close as possible to the existing structure to minimize footprint	• Development of Wetland Compensation Plan • If applicable, monitoring and functional analysis of replacement wetland habitat to determine if constructed wetlands are suitable compensation
Local Economy	• Open and early communication with landowners • Ongoing Liaison/information through a CLC and municipal officials to reduce disruption and promote economic planning • Underpasses/overpasses to maintain or improve access where practical • Appropriate signage, lighting, landscape design at interchanges • Explore construction of a visible Visitor Information Centre • Strategic planning for new economic growth • Fair and reasonable compensation and/or land swap • Adequate planning time • Traffic Management	• Monitoring during construction phase by the Project Engineers to ensure that access to businesses and other establishments are adequately maintained and signage is provided as necessary • Monitoring of long term effects on local businesses and the economy through the CLC and periodic reporting of findings to NSTPW and municipal officials who will jointly determine remedial actions needed
Land Use	• Open and early communication with landowners through the CLC and other mechanisms • Adequate relocation time • Fair and reasonable compensation and/or land swap • Noise and dust controls including restricted working hours • Traffic management • Overpass/underpasses to maintain access • Maintain, to the extent possible, existing access roads • Maintain access to properties; negotiate with landowners to realign/construct replacement access roads during construction	• CLC to remain in close consultation with property owners along the RoW to discuss scheduling, temporary and permanent alternate access roads, and to monitor other Project elements of concern to local residents and landowners

Table 12.1 Summary of VEC/VSC Specific Mitigation and Monitoring Requirements

VEC/VSC	Mitigation	Follow-up and Monitoring
Archaeological and Heritage Resources	• Documentation and test excavation of standing heritage resources prior to disturbance (*i.e.*, additional archival research, test excavations) • Monitoring of area of nineteenth century carriage house during construction at South River crossing	• Monitoring during construction activities if necessary
Transportation	• Alignment location and access roads will minimize impacts to severed properties • Kell and Cunningham Roads traffic volumes are low and a convenient service road to Trunk 7 will be provided • Adherence to *Nova Scotia Temporary Workplace Traffic Control Manual* • Locate paving batch plants adjacent to new alignment	• Traffic counts will be done every three years as per NSTPW standard procedure

The mitigative measures contained in this report, along with standard mitigative construction and operation procedures will be documented in an EPP for construction and operation of the highway.

Operation of a four-lane controlled access highway in the study area will provide safe, convenient, economic and efficient movement of persons and goods through the area. Thus a positive effect will be provided to the province with the development of this Project. Decreased traffic along the existing Highway 104, will contribute to a quieter, safer living environment for most residents. Most of the heavy trucks (through traffic) that traverse the existing Highway 104 will divert to the new highway reducing public concerns for safety and noise.

In summary, this Project will provide a long term public benefit by reducing current traffic volumes on the existing Highway 104. It will also provide infrastructure to handle future traffic volumes and patterns, thereby improving public safety.

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APPENDIX A

TERMS OF REFERENCE AND CONCORDANCE TABLE

TERMS OF REFERENCE

AS REQUIRED BY

THE ENVIRONMENT ACT AND
THE CANADIAN ENVIRONMENTAL ASSESSMENT ACT

NOVA SCOTIA DEPARTMENT OF
TRANSPORTATION AND PUBLIC WORKS

Highway 104 at Antigonish, Antigonish County, N.S.

NOVA SCOTIA
DEPARTMENT OF ENVIRONMENT AND LABOUR
in cooperation with
TRANSPORT CANADA & FISHERIES AND OCEANS CANADA

February, 2002

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FOREWORD

Presented in this document are the Terms of Reference for the Environmental Assessment Report ("Report") required for the Highway 104 at Antigonish Project in accordance with the requirements of Part IV of the *Environment Act* (1995). The Nova Scotia Department of Transportation and Public Works ("Proponent") must include the information requested within the Terms of Reference in the Report and prepare the Report in accordance with the Environmental Assessment Regulations pursuant to Part IV of the *Environment Act*.

This Terms of Reference includes typical Valued Environmental Components (VEC's) associated with highway construction projects which must be adequately addressed in the Report. The Proponent must identify any additional VEC's to be examined during the assessment process.

The order in which information is presented is at the discretion of the Proponent, however, a concordance table will be required to indicate where the information is presented. The Proponent may provide additional information where considered appropriate. Since the Report is intended for public review, the information should be presented in non-technical language wherever possible and appropriate, including a non-technical executive summary. The Proponent will be required to submit an electronic copy of the Report in WordPerfect and PDF format, for publication on the Department's website. Any images contained within the Report shall be submitted as either .jpg or a .gif file format or some other electronic format as determined by the EA Branch

Transport Canada and Fisheries and Oceans Canada (Habitat and Coast Guard) have indicated that this project will likely require review under the *Canadian Environmental Assessment Act (CEAA)*. The Nova Scotia Department of Environment and Labour will coordinate, where possible and practical, with the federal process. The final version of the Terms of Reference includes environmental assessment requirements pursuant to the Nova Scotia Environmental Assessment Regulations and the *CEAA*. The Nova Scotia Department of Transportation and Public Works must make provision for meeting with federal and provincial departments to review expectations for the environmental assessment as set out in the Terms of Reference and as set out in detailed supporting guidance provided by expert federal and provincial authorities. This detailed supporting guidance can be accessed from the Federal Environmental Assessment Index (FEAI) maintained by the Canadian Environmental Assessment Agency.

1.0 INTRODUCTION

This section of the Report shall introduce the reader to the Report.

2.0 PROJECT DESCRIPTION

This section of the Report shall describe the project particularly as it is planned to progress through the construction and operation phases of its life. The description should also address other phases of the project as can reasonably be foreseen including modification, decommissioning and abandonment. Any assumptions which underlie the details of the project design shall be described, including impact avoidance opportunities inclusive of pollution prevention, and adherence to best management practices. Where specific codes of practice, guidelines and policies apply to items to be addressed, those documents shall be cited and included as appendices to the Report, including mapping at an appropriate scale.

Items to be addressed shall include, but not be limited to:

2.1 Highway Corridor Location

Ultimate boundaries of the proposed corridor and highway route in a regional context showing existing and proposed land uses and infrastructure such as road networks, railways, power lines, pipelines, proximity to settled areas, individual and community water supplies, wetlands, ecologically sensitive areas and archaeological sites shall be described.

2.2 Construction Methods, Schedule and Other Constraints

This section shall include, but not necessarily be limited to, a description of the following, including locations, scheduling details and estimates of magnitude or scale where possible:

2.2.1 general construction practices, including but not limited to:
  - pit and quarry operations
  - erosion and sedimentation control;

2.2.2 description of vehicle types, truck routes, hours of operation of vehicles to be used in highway construction;

2.2.3 proposed construction schedules, including proposed time frames for right-of-way clearing and slash disposal and timing of highway construction, and construction work adjacent to watercourses;

2.2.4 identification of areas requiring major cut and/or fill operations.

2.2.5 timing and extent of surveys for flora, fauna, and ecologically sensitive areas.

2.3 Structures

Describe the typical structures proposed for all watercourse and wetland crossings and for any proposed wildlife corridors.

2.4 Acid Producing Bedrock

Provide the location and an estimate of the volume of net acid producing bedrock to be disturbed.

2.5 Borrow Material

Describe the acceptable types of borrow material for highway construction and any currently identified sources likely to be used in the highway construction.

2.6 Paving Materials

Describe the proposed road paving materials.

2.7 Construction Waste Disposal

Describe the criteria for the selection of candidate sites for:

- the disposal of excess/waste excavated rock and overburden, including locations of any currently known planned disposal sites, including those for acid producing slates;
- the disposal of organic soil, slash, grubbing and wood fibre, including

locations of any currently known or planned disposal sites.

3.0 REGULATORY ENVIRONMENT

Describe the existing regulatory environment (Federal, Provincial, Municipal) including all permitting, licensing and regulatory requirements, appropriate guidelines and Municipal Planning Strategy and Land Use Bylaw requirements that apply to all phases of this proposal.

4.0 REASON FOR THE UNDERTAKING

In recognition of the fact that the project has a potentially negative impact upon the environment, this section shall discuss the public need for the undertaking.

5.0 A DESCRIPTION OF ALTERNATIVES TO THE UNDERTAKING

This section of the Report shall describe functionally different ways to meet the project need and achieve the project purpose. This discussion shall address but not necessarily be limited to other modes of transportation, upgrading of existing roadway and the null (do nothing) alternative.

6.0 OTHER METHODS FOR CARRYING OUT THE UNDERTAKING

This section of the Report shall detail the process the proponent undertook to determine the proposed corridor, including a discussion of other alignments considered, including the "less expensive and less disruptive" alignment indicated in Section 3.4 of the registration document. The environmental and socio-economic selection criteria (e.g., construction costs, fuel savings, technical factors) for the preferred corridor and alternative corridors shall be provided. The Report shall discuss other methods for implementing the registered undertaking, including, but not necessarily be limited to, items such as adjusting median width and different methods for watercourse crossings.

7.0 ASSESSMENT METHODOLOGY

This section shall include the study strategy, methodology and boundaries, within which the Report will be prepared.

The following must be clearly defined:

a) The Valued Environmental Components (VEC's)[1] within the study boundaries and the methodology used to identify the VEC's. The methodology shall include input from members of the public, government department and agencies and other interested parties.

b) The temporal boundaries (i.e. duration of specific project activities and potential impacts) for construction and operation.

c) The study boundaries or project area and all space that will be potentially impacted by the project as proposed or subject to subsequent modifications and the methodology used to identify the study boundaries.

d) The strategy for investigating the interactions between the project and each VEC and how that strategy will be used to coordinate the individual studies undertaken.

e) The strategy for assessing the project's contribution to cumulative impacts on each VEC, as required by federal departments under the *CEAA*.

f) The strategy for predicting and evaluating project impacts upon the environment; determining necessary mitigation, remediation and/or compensation; and evaluating residual impacts.

The following sections outline specific concerns and requirements related to the existing environment, adverse effects and environmental effects assessment, proposed mitigation, residual environmental impacts, proposed compliance and effects monitoring and the public information program that are to be addressed in the Report for the proposed undertaking.

8.0 EXISTING ENVIRONMENT

This section of the Report shall identify the study area and shall describe the existing environmental components, their interrelationship and their sensitivity to disturbance. This information shall reflect four seasons in the study area where appropriate, through the use of original baseline studies of existing data.

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[1] Within the Nova Scotia Environmental Assessment Regulations, Valued Environmental Components are interpreted as environmental, socio-economic, human health, reasonable enjoyment of life and property, cultural, historical, archaeological, paleontological and architectural features that may be impacted, whether positive or negative, by the proposed undertaking.

The Report shall clearly indicate baseline data/information which is not available or existing data which cannot accurately represent environmental conditions in the project area over four seasons.

If the background data have been extrapolated or otherwise manipulated to depict environmental conditions in the project area, modeling methods and equations shall be described and shall include calculations of margins of error.

All categories and constraints covered in the Highway Environmental Database Study screening matrix shall be included in this section of the Report.

The components of the environment to be discussed shall include identified VEC's and the following:

8.1 Area Geography

Describe the study area geography and topography including features such as lakes, streams, wetlands, and topography within a minimum of five hundred (500) meters of the centerline of the proposed alignment and those features outside 500 meters which influence features within the proposed corridor.

8.2 Existing and Planned Land Uses

Describe the patterns of current and planned land use and settlement along the proposed highway corridor including, but not limited to, planning strategies, proposed development, utilities (including natural gas pipelines) and development boundaries. Describe any current land uses by First Nations along the proposed highway corridor.

Discuss plans for a survey of structures along the highway route where blasting is planned. The survey shall include structures and building foundations which may experience damage or impact due to seismic vibration or air concussion.

8.3 Socio-Economic Conditions and Recreational Opportunities

Describe the current socio-economic conditions of the area along the proposed highway corridor. Include population demographics, economic conditions , and recreational opportunities in the area.

8.4 Atmospheric Conditions

8.4.1 Describe the air quality to include, but not necessarily be limited to, wind speeds and directions, precipitation amounts and precipitation chemistry. Particular attention is to be paid to ambient dust levels in areas where construction activities may contribute to increased dust levels.

8.4.2 Describe the weather patterns along the proposed route as they relate to highway operation and maintenance. Include how snow, ice and wind conditions may be expected to change with geographic conditions and seasons, and how these relate to the proposed project.

8.4.3 Describe what Probable Maximum Precipitation levels are used and how they relate to the proposed project.

8.5 Ambient Noise Levels

Provide a baseline study of all residential and other sensitive areas (i.e., commercial, recreational and institutional) within two hundred (200) meters of the proposed right of way and at any other areas where traffic noise could be expected to have a significant negative impact. Background ambient noise levels should be characterized for various locations along the corridor where traffic noise on the proposed highway could be expected to be heard and felt to be a negative impact, i.e., residential areas, commercial areas, recreational, institutional areas and sensitive wildlife habitats.

8.6 Surface Water

Provide a general hydrologic, hydraulic and water quality description of all surface water bodies in the vicinity of the project, especially downstream of the project. Provide baseline water quality and quantity studies which will form the basis for a subsequent environmental effects monitoring program. The drainage areas of individual streams both above and below the proposed highway shall be described. This description shall include the calculation of the drainage area upstream of each watercourse crossing, and assess water quality over four seasons prior to construction. Based on seasonal flow estimates, and on prior salt loading data for the area, estimate salt and budget loading to the surface waters and potential change in water quality.

Existing uses and users of the watercourses shall be identified.

8.7 Groundwater

Provide a general hydrologic, hydrogeologic, and water quality description of the groundwater in the study area.

Provide plans for a well water quality and quantity survey of all domestic and other wells within the expected impact area of the highway corridor. Locations of all wells in the anticipated impact area shall be identified and plotted, including but not limited to, the identification of any subdivisions or trailer courts which have their own water supply. Identify potential areas for groundwater supply development within the study area.

8.8 Flora, Fauna and Habitat Evaluation

Identify the following types of flora, fauna, and habitat. Appropriate field surveys agreed to by the Nova Scotia Department of Natural Resources, Wildlife Division shall be conducted as part of the evaluation.

8.8.1 Identify typical species of flora, flora species-at-risk, and potential habitat for flora species-at-risk in the study area. Current information shall be obtained from the Nova Scotia Department of Natural Resources, Wildlife Division; the Atlantic Canada Conservation Data Center; Environment Canada; the Nova Scotia Museum of Natural History and local naturalists and interest groups. Field surveys and investigations required to supplement the available data shall be completed in a manner that is acceptable to the Nova Scotia Department of Natural Resources (Wildlife Division). Available data, survey results, and detailed mitigation measures that demonstrate a special emphasis on avoidance of impacts shall be included in the EA documentation.

8.8.2 Identify any wildlife management areas, ecological reserves, wilderness areas, managed wetlands and significant wildlife habitat, including areas with high wildlife concentrations, wildlife corridors or habitats rare to Nova Scotia.

8.8.3 Identify typical species of fauna (including migratory species), fauna species-at-risk , and potential habitat for fauna species-at-risk in the study area. Current information shall be obtained from the Nova Scotia Department of Natural Resources, Wildlife Division; the Atlantic Canada Conservation Data Center; Environment Canada; the Nova Scotia Museum of Natural History; the latest Committee on the Status of Endangered Wildlife in Canada (COSEWIC) list, and the *Atlas of Breeding Birds of the Maritime Provinces*, and local naturalists and interest groups. Field surveys and investigations required to supplement the available data shall be completed in a manner that is acceptable to the Nova Scotia Department of Natural Resources (Wildlife Division). When surveys are necessary to supplement the available data and adequately describe the use of the area by migratory birds during different times of the year (breeding season, migration, winter), emphasis will be placed on determining whether any bird species-at-risk, colonial nesting species, species particularly vulnerable to habitat fragmentation, etc., occur or breed in or near the study area, as required by federal departments under the *CEAA*. Available data, survey results, and detailed mitigation measures that demonstrate a special emphasis on avoidance of impacts shall be included in the EA documentation.

8.8.4 Identify fish habitat that includes, but is not restricted to, stream size, bottom composition, stream gradient at each potential watercourse crossing, and annual temperatures and sediment loading where data is available from appropriate regulatory and resource agencies, including, but not limited to, the Nova Scotia Department of Agriculture and Fisheries, Fisheries and Oceans Canada, and the Nova Scotia Museum of Natural History. Fish spawning, rearing nursery, food supply and migration areas are to be evaluated within the predicted zone of influence. Describe the criteria utilized for determining the zone of influence this project has on the fish habitat of the watercourse involved.

8.8.5 Describe the relative distribution, abundance, composition and socioeconomic importance of valued fish resource components within the predicted zone of influence of all proposed watercourse crossings. Fish species, age, health and diversity shall be described. Electrofishing shall be carried out as per Fisheries and Oceans Canada's permits and requirements.

8.9 Forestry Resources

Describe any forestry resources and forestry uses within the proposed corridor.

8.10 Wetland Resources

Identify the location, size and class of any wetland within the predicted zone of influence and conduct a wetland evaluation. The true ecosystem value of each wetland shall be examined through on-site investigations using comprehensive valuation methodology that assesses component, functional and attribute values. Field surveys and investigations required to supplement the available data shall be completed in a manner that is acceptable to the Nova Scotia Department of Natural Resources (Wildlife Division) and the Nova Scotia Department of Environment and Labour.

The Federal Policy on Conservation of Wetlands, as required by federal departments under the *CEAA*, will be taken into account on all wetlands which will be potentially impacted directly or indirectly. The importance of salt marsh in the area will be reflected and discussed in the analysis.

8.11 Fishery Resources

Describe any commercial fisheries, including marine fisheries and aquaculture, recreational and First Nations fishing in the area of the undertaking. Describe the commercial and recreational species caught, fishing locations, amount caught, and fishing methods used.

8.12 Bedrock and Surficial Geology

Provide a general description of the bedrock and surficial geology of this study area, to include but not necessarily be limited to a discussion of:

8.12.1 The bedrock geology along the proposed corridor.

8.12.2 Acid production/consumption data for all potential acid generating bedrock formations that will be encountered and disturbed by the highway proposal.

8.12.3 The surficial cover including overburden depth, soil types, permeability and porosity, and areas of high erosion risk.

8.12.4 The potential for disturbance of contaminated soils.

8.12.5 Any areas having known or proven economic mineral deposits, areas under advanced mineral exploration, and the location and extent of existing and abandoned mines, pits and quarries.

8.13 Historical, Archaeological, Paleontological and Architectural Resources

Identify any locations containing sites or features of historical, archaeological, paleontological, or architectural importance, including First Nations, in a manner acceptable to the Nova Scotia Museum. The archeological assessment shall be conducted under the terms of a Heritage Research Permit for Archaeology issued under the *Special Places Protection Act* ,and in conjunction with the Nova Scotia Museum and Mi'kmaq. Describe the nature of the sites or features located in those areas.

8.14 Transportation

Describe the existing road conditions in the area, including class of road, traffic volumes and traffic types, and the road surface conditions.

9.0 ADVERSE EFFECTS AND ENVIRONMENTAL EFFECTS ASSESSMENT

The Report shall identify and predict the magnitude and significance of project impacts, both positive and negative, on the environment. "Adverse effects" and "environmental effects" are defined under the *Environment Act* and under the *CEAA*. This section shall specifically address the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects[2] that are likely to result from the project in combination with other past, present and reasonably foreseeable projects or activities, as required by federal departments under the *CEAA*. This section shall also address impacts on identified VEC's, as well as, but not limited to, the following socio-economic, community and bio-physical environmental impacts.

9.1 Impacts on Land Use

Predict the impacts of the highway, including the effects of fragmentation of landholding, on the existing and planned land uses, including, but not limited to planning strategies, proposed development, utilities (including natural gas pipelines) and development boundaries. Discuss the potential for the impact on structures along the highway route where blasting is planned. Discuss the impacts of the project on local climate, including cold-air drainage patterns, as they relate to other resource-use activites (e.g. agriculture),as required by federal departments under the *CEAA*.

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[2] Ref: Cumulative Effects Assessment Practitioners Guide, February, 1999; available from the Canadian Environmental Assessment Agency

9.2 Impacts on Socio-Economic Conditions and Recreational Opportunities

9.2.1 Discuss the impact on residential property values.

9.2.2 Discuss the effect of proposed interchange locations and grade separated crossings on present and future expansion of commercial/residential/institutional/recreational and resource land uses within the study area.

9.2.3 Discuss the impact on recreational opportunities, including the effects on aesthetics (view planes etc) and ramifications to ecotourism.

9.2.4 Discuss the impact on proposals for hiking trail development, especially for any developments proposed for abandoned railways.

9.2.5 Discuss the impact on First Nations' current uses of land and resources for traditional purposes and on land claims within the proposed highway corridor.

9.3 Impacts on Atmospheric Conditions

9.3.1 Discuss the impact of dust generated from highway construction on residential, agricultural, recreational and institutional areas.

9.3.2 Discuss the potential for micro-climate modifications in the vicinity of the project.

9.3.3 Description of the management strategy to reduce Greenhouse Gas (GHG) emissions related to the project. Estimate GHG emissions associated with various project phases, including site preparation, construction, and maintenance phases of the project. Discuss the potential loss of carbon sinks, as required by federal departments under the *CEAA*.

9.4 Noise Impacts

Discuss any predicted increase and impact of background noise levels from highway construction activity and from traffic on residential, commercial, recreational and institutional areas and sensitive wildlife species.

9.5 Impacts on Surface Water and Run-off

9.5.1 Identify receiving waters and associated watersheds for run-off during construction and operational phases, and discuss all associated impacts to surface water quality, fish habitat and groundwater. The CCME Canadian Water Quality Guidelines as they pertain to aquatic life and existing ambient water quality shall be used as a context for addressing the magnitude and importance of the predicted impacts.

9.5.2 Discuss the potential for soil eroding from the highway into adjacent watercourses.

9.5.3 Discuss the criteria used for design of run-off control features, i.e., expected run-off volumes, storm design data, etc. This section shall indicate if allowance has been made for potential changes in precipitation due to climate change.

9.5.4 Provide the predicted impacts on surface water and vegetation resulting from the use of ice and snow control procedures, and from other maintenance activities. If the use of road salt is proposed, discuss the impacts in the context that road salt is now recognized as toxic under the *Canadian Environmental Protection Act* , as required by federal departments under the *CEAA*.

9.5.5 Discuss the predicted impacts resulting from the disturbance of contaminated soils.

9.5.6 Indicate the watercourses to be impacted and provide a description of the impacts.

9.5.7 Indicate and discuss the probabilities of spills/accidents and the environmental consequences of such events. Discuss the potential impact of contaminated run-off on the environment, including the accidental release of a hazardous substance.

9.5.8 Identify the amount of flood plain to be infilled adjacent to each of the proposed watercourse crossings and discuss the potential for downstream destabilization of stream channels and associated fish habitat.

9.6 Impacts on Groundwater

Predict any anticipated changes to groundwater quality and quantity and the significance of the anticipated changes including impacts of groundwater contaminated from road de-icing practices. If the use of road salt is proposed, the impacts shall be discussed in the context that road salt is now recognized as toxic under the *Canadian Environmental Protection Act*, as required by federal departments under the *CEAA*.

Indicate and discuss the probabilities of spills/accidents and the environmental consequences of such events. Discuss potential impacts of contaminated groundwater on fish, fish habitat and water quality.

9.7 Impacts on Flora, Fauna and Habitat

Predict the impacts of construction and operation of the project on terrestrial and aquatic flora, including a full accounting of impacts on species of concern and significant habitat.

Predict the impacts of construction and operation of the project on terrestrial and aquatic fauna, including avifauna, and include a full accounting of impacts on species of concern and significant habitats. Discuss the impacts of fragmentation on wildlife populations and habitats including any interruption, alteration or destruction of wildlife corridors. The potential impacts on migratory bird habitat shall be assessed.

9.8 Impacts on Forestry

Predict the impacts on any forestry resources within the project area.

9.9 Impacts on Wetlands

Predict the impacts to all wetlands which may be affected by the proposed project including wetlands which may be created through the construction of the highway.

9.10 Impacts on Fishery Resources

Predict the impacts on commercial fisheries, including marine fisheries and aquaculture, recreational and First Nations fishing which may be impacted by the proposed project.

9.11 Geological Impacts

Discuss the potential for the impact of acidic water run-off from bedrock disturbed by highway construction on Valued Environmental Components.

9.12 Impacts on Historical, Archaeological, Paleontological and Architectural Resources

Predict the project related impacts to all structures, sites, resources or things of historical, archaeological, paleontological or architectural significance.

9.13 Impacts on Transportation

9.13.1 Discuss the anticipated changes in traffic speed and density in adjacent residential and commercial areas.

9.14 Impacts of the Environment on the Project

9.14.1 Discuss the effect the environment may have on the construction and operation phases of the project, including weather and climate elements. Any necessary climate information to validate statements made in the assessment will be provided.

9.14.2 Discuss how the project accommodates the potential effects of climate change in its design considerations, such as culvert design specifications.

10.0 EVALUATION OF THE ADVANTAGES AND DISADVANTAGES TO THE ENVIRONMENT

This section shall present an evaluation of the advantages and disadvantages to the environment, including the VEC's during the construction and maintenance phases of the undertaking. This section shall include a detailed description of the methodologies used to describe or predict these results. Assessment objectives for each VEC will be articulated to guide the interpretation of assessment findings.

11.0 PROPOSED MITIGATION

The Report shall describe all measures that are technically and economically feasible that have or will be taken to avoid or mitigate significant negative impacts and maximize the positive environmental effects of the project, with emphasis on pollution prevention, impact avoidance, and best management practices (as described in Section 9.0, Adverse Effects and Environmental Effects Assessment). Mitigation includes the elimination, reduction or control of the adverse effects or the significant environmental effects of the project and may include restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means.

Describe compensation that will be provided when environmental damage is unavoidable or cannot be adequately mitigated by any other means. This section shall address, but not necessarily be limited to the following:

11.1 Regulatory Compliance

Describe any legislation, regulations, guidelines, policies and specifications will be adhered to during design and construction of the roadway, that will lead to mitigation of environmental impacts.

11.2 Existing and Planned Land Uses

Describe the corridor selection process and indicate how the chosen alignment minimizes/mitigates impacts on existing and planned land uses.

Discuss the plans for mitigating potential impacts on structures along the highway route where blasting is planned.

11.3 Socio-Economic Conditions and Recreational Opportunities

Describe actions that will be taken to mitigate adverse impacts on private and commercial property and on human activities, including First Nations. Discuss plans for compensation for any possible loss of property or property value.

Provide a dispute resolution policy for addressing project related complaints and concerns that may be received from nearby land owners or residents.

11.4 Air Quality

Describe measures that will be taken to control dust during highway construction.

11.5 Noise Impacts

Describe measures that will be taken to mitigate increased noise levels during highway construction and operation.

11.6 Surface Water Quality and Quantity

Present an outline of siltation, erosion and run-off control features, storm drainage management procedures and mitigation measures including specific references to seasonal variation, that will be used in the following situations: (a) clearing and grubbing of the proposed corridor, (b) installation of watercourse structures, (c) subgrade work, (d) construction of service roads, and (e) highway maintenance. The Report shall also provide a commitment that the Nova Scotia Department of Transportation and Public Works will prepare an Environmental Protection Plan for the above activities.

Particular attention shall be given to those areas which are expected to present significant challenges for sediment and erosion control. Most notably, the South River bridge crossing which will require excavation of large amounts of highly erodable soil on steep approaches to the bridge. The South River supports a diverse and healthy freshwater fisheries resource and the crossing is in an area of salt marsh which is critical to both freshwater and marine fisheries resources. Other crossings, such as tributaries to the Briley Brook system are in areas of highly erodable soil and are the sites of extensive and highly successful fish habitat restoration projects.

If contaminated soils are to be disturbed, discuss methods to minimize adverse impacts.

Discuss commitments to provide contingency and remediation plans for any contamination of or drainage to surface water resources, including decrease of water quality.

If road salt is to be used, establish a road salt management strategy for the project.

11.7 Groundwater Quality and Quantity

Describe actions that will be taken to moderate any negative impacts on groundwater quality and quantity.

Describe measures to be employed in the event of accidental dewatering of domestic water supply wells through highway construction activity including compensation for loss or degradation of domestic water supplies.

Discuss commitments to provide contingency and remediation plans for any contamination of or drainage to groundwater resources, including decrease of water quality.

If road salt is to be used, establish a road salt management strategy for the project.

11.8 Flora, Fauna and Habitat

Discuss measures that will be taken to minimize the impacts of road construction and operation on flora species. Include any plans for landscaping and preservation of existing vegetation. Demonstrate how a priority will be placed on the use of native species for revegetation efforts.

Describe the measures that will be taken to minimize the impacts of road construction and operation on terrestrial and aquatic fauna (including avifauna). Include any plans for preservation of existing habitat and compensation for loss or degradation of aquatic and terrestrial habitat (i.e.habitat rehabilitation or replacement).

Discuss commitments to provide contingency and remediation plans for drainage to aquatic and terrestrial habitat as a result of accidental events.

11.9 Forestry Resources

Discuss measures that will be taken to minimize the impacts of road construction and operation on forestry resources.

11.10 Wetland Resources

Discuss avoidance of wetland de-watering and mitigation measures to maintain ecological and hydrological integrity of any wetlands in the area. Identify plans for the preservation of existing wetlands and compensation for loss or degradation of the functional values of wetlands impacted by the project. Also include plans to monitor the success of mitigative action. Due to the location of the project, demonstrate how an emphasis will be placed on avoidance of potential losses of wetland function, particularly in salt marsh function.

11.11 Fishery Resources

Describe the timing of work in and immediately adjacent to watercourses, and fish passage at watercourse crossings.

11.12 Geological Resources

Describe alternatives to disrupting net acid producing bedrock. When no practical alternative to exposing this bedrock exists, mitigation plans shall be developed for minimizing the impacts on the aquatic environment.

Discuss commitments to provide contingency and remediation plans for watercourses that have been degraded due to the disturbance of acid-generating bedrock of tills.

11.13 Historical, Archaeological, Paleontological and Architectural Resources

Describe mitigation measures to preserve, protect, or recover any features of socio-economic, cultural, archaeological or paleontological value that are identified in the proposed highway corridor.

11.14 Transportation

Discuss the mitigation measures planned to address anticipated impacts from any predicted changes in traffic speed and density in adjacent residential and commercial areas.

12.0 RESIDUAL ADVERSE EFFECTS AND ENVIRONMENTAL EFFECTS

This section of the Report shall list and contain a detailed discussion and evaluation of residual impacts, including the criteria for determining significance. The Report shall note where uncertainty exists regarding the significance of the residual impacts. Residual impacts are those adverse effects or significant environmental effects which cannot or will not be avoided or mitigated through the application of environmental control technologies or other acceptable means. Those impacts that cannot be mitigated or avoided shall be clearly distinguished from those impacts that will not be mitigated or avoided. Positive residual impacts will also be discussed and evaluated.

These impacts become important in the evaluation of a proposed project as they represent the environmental cost/benefit of the project.

Any changes to the project that may be caused by the environment and the significance of those changes should be described in this section of the Report.

The Report shall contain a concise statement and rationale for the overall conclusion relating to the significance of the residual adverse environmental effects. The Report shall, for ease of review, include a matrix of the environmental effects, proposed mitigation and residual adverse effects.

13.0 PROPOSED COMPLIANCE AND EFFECTS MONITORING PROGRAMS

The Environmental Assessment Report shall include a framework upon which compliance and effects monitoring will be based throughout the life of the proposed project, including abandonment. The discussion of compliance monitoring shall include, but not necessarily be limited to, plans and procedures for water quality compliance monitoring, especially for suspended sediment and pH levels, during construction. Monitoring programs must be designed to determine the effect of the implemented mitigation measures. In addition, the Report shall also describe a program, including regular inspections and periodic biological investigations, designed to monitor the accuracy of predicted impacts, as required by federal departments under the *CEAA*. Effects monitoring during all phases of this project, including post completion, shall include avifaunal surveys for waterfowl, raptors, or any species of concern.

This section shall also include, but not be limited to, commitments to undertake the following surveys prior to blasting operations in the corridor or at associated quarry sites.

13.1 Pre-Blast Survey

Discuss plans to follow-up on the pre-blast survey, including a survey of structures along the highway route where blasting wells, building foundations, etc. may have experienced damage or impact due to seismic vibrations or air concussion.

13.2 Well Water Survey

Discuss plans for periodic monitoring of water quality and quantity of springs (if used as a water supply), and domestic and other wells where blasting operations are proposed and where significant roadway cuts that do not involve blasting are planned.

14.0 PUBLIC INFORMATION PROGRAM

This section of the Report shall detail the public information program initiated by the Proponent. The Proponent shall describe in detail the opportunities that have been or will be provided to allow the public to express their concerns and receive information on the various phases of project development including planning design, environmental assessment review, operation, abandonment, site rehabilitation, post abandonment and monitoring.

The results of public participation and information sessions shall detail how public comments were addressed, including any commitments made by the Proponent.

Table A1 Concordance Table

NSDEL Terms of Reference	EA Report
1.0 Introduction	1.0 Introduction
2.0 Project Description	2.0 Project Description
2.1 Highway Corridor Location	2.2 Project Scope and Location
2.2 Construction Methods, Schedule and Other Constraints	2.3 Construction Schedule 2.4 Construction Activities
2.3 Structures	2.4.3 Construction Activities: *Structures*
2.4 Acid Producing Bedrock	2.4.12 Construction Activities: *Acid Producing Bedrock*
2.5 Borrow Material	2.4.8 Construction Activities: *Borrow Materials*
2.6 Paving Materials	2.4.7.3 Highway Construction: *Pavement*
2.7 Construction Waste Disposal	2.4.11 Construction Activities: *Construction Waste Disposal*
3.0 Regulatory Environment	3.3 Regulatory Environment
4.0 Reason for the Undertaking	2.1 Purpose and Need for the Project
5.0 A Description of Alternatives to the Undertaking	2.7.1 Project Alternatives: *Alternatives to the Project*
6.0 Other Methods for Carrying Out the Undertaking	2.7.2 Project Alternatives: *Other Methods for Carrying Out the Proposed Project*
7.0 Assessment Methodology	4.0 Environmental Assessment Methodology
8.0 Existing Environment	3.0 Environmental Setting Sections 5.0 and 6.0 under various VECs and VSCs
8.1 Area Geography	3.1 Environmental Setting: *Biophysical Environment*
8.2 Existing and Planned Land Uses	3.2 Environmental Setting: *Socioeconomic Environment* 6.2 Socioeconomic Effects Assessment: *Land Use*
8.3 Socio-Economic Conditions and Recreational Opportunities	3.2 Environmental Setting: *Socioeconomic Environment* 6.1 Socioeconomic Effects Assessment: *Local Economy* 6.2 Socioeconomic Effects Assessment: *Land Use*
8.4 Atmospheric Conditions	5.1 Environmental Effects Assessment: *Atmospheric Environment* 9.0 Effects of the Environment on the Project
8.5 Ambient Noise Levels	5.1 Environmental Effects Assessment: *Atmospheric Environment*
8.6 Surface Water	5.3 Environmental Effects Assessment: *Fish and Fish Habitat*
8.7 Groundwater	5.2 Environmental Effects Assessment: *Groundwater Resources*

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NSDEL Terms of Reference	EA Report
8.8 Flora, Fauna and Habitat Evaluation	3.1 Environmental Setting: *Biophysical Environment* 5.3 Environmental Effects Assessment: *Fish and Fish Habitat* 5.4 Environmental Effects Assessment: *Rare Herpetiles* 5.5 Environmental Effects Assessment: *Rare Mammals and critical Habitat* 5.6 Environmental Effects Assessment: *Rare and Sensitive Birds* 5.7 Environmental Effects Assessment: *Rare Plants and Plant Communities* 5.8 Environmental Effects Assessment: *Wetlands*
8.9 Forestry Resources	6.1 Socioeconomic Effects Assessment: *Local Economy*
8.10 Wetland Resources	3.1 Environmental Setting: *Biophysical Environment* 5.1 Environmental Effects Assessment: *Wetlands*
8.11 Fishery Resources	3.1 Environmental Setting: *Biophysical Environment* 5.3 Environmental Effects Assessment: *Fish and Fish Habitat*
8.12 Bedrock and Surficial Geology	2.4.12 Construction Activities: *Acid Producing Bedrock* 2.4.13 Construction Activities: *Karst Topography* 3.1 Environmental Setting: *Biophysical Environment* 5.2 Environmental Effects Assessment: *Groundwater Resources*
8.13 Historical, Archaeological, Palaeontological and Architectural Resources	3.2 Environmental Setting: *Socioeconomic Environment* 6.3 Socioeconomic Effects Assessment: *Archaeological and Heritage Resources*
8.14 Transportation	6.4 Socioeconomic Effects Assessment: *Transportation Infrastructure*
9.0 Adverse Effects and Environmental Effects Assessment	4.0 Environmental Assessment Methodology Sections 5.0 and 6.0 Various VECS/VSCs Under Analysis, Mitigation and Residual Effects Prediction and Summary of Residual Environmental Effects Assessment
9.1 Impacts on Land Use	6.2 Socioeconomic Effects Assessment: *Land Use*
9.2 Impacts on Socio-economic Conditions and Recreational Opportunities	6.1 Socioeconomic Effects Assessment: *Local Economy*
9.3 Impacts on Atmospheric Conditions	5.1 Environmental Effects Assessment: *Atmospheric Environment*
9.4 Noise Impacts	5.1 Environmental Effects Assessment: *Atmospheric Environment*
9.5 Impacts on Surface Water and Run-off	5.3 Environmental Effects Assessment: *Fish and Fish Habitat*
9.6 Impacts on Groundwater	5.2 Environmental Effects Assessment: *Groundwater Resources*

Table A1 Concordance Table

NSDEL Terms of Reference	EA Report
9.7 Impacts on Flora, Fauna and Habitat	5.3 Environmental Effects Assessment: *Fish and Fish Habitat* 5.4 Environmental Effects Assessment: *Rare Herpetiles* 5.5 Environmental Effects Assessment: *Rare Mammals and critical Habitat* 5.6 Environmental Effects Assessment: *Rare and Sensitive Birds* 5.7 Environmental Effects Assessment: *Rare Plants and Plant Communities* 5.8 Environmental Effects Assessment: *Wetlands*
9.8 Impacts on Forestry	6.1 Socioeconomic Effects Assessment: *Local Economy*
9.9 Impacts on Wetlands	5.8 Environmental Effects Assessment: *Wetlands*
9.10 Impacts on Fishery Resources	5.3 Environmental Effects Assessment: *Fish and Fish Habitat*
9.11 Geological Impacts	5.2 Environmental Effects Assessment: *Groundwater Resources* 5.3 Environmental Effects Assessment: *Fish and Fish Habitat*
9.12 Impacts on Historical, Archaeological, Palaeontological and Architectural Resources	6.3 Socioeconomic Effects Assessment: *Archaeological and Heritage Resources*
9.13 Impacts on Transportation	6.4 Socioeconomic Effects Assessment: *Transportation Infrastructure*
9.14 Impacts of the Environment on the Project	9.0 Effects of the Environment on the Project
10.0 Evaluation of the Advantages and Disadvantages to the Environment	Section 4.0 Environmental Assessment Methodology Section 5.0 Various VECs 9.0 Effects of the Environment on the Project
11.0 Proposed Mitigation	Sections 5.0 and 6.0 Various VECS/VSCs Under Analysis, Mitigation and Residual Effects Prediction 10.0 Environmental Management and Monitoring 12.0 Summary and Conclusions
11.1 Regulatory Compliance	Section 3.3 Regulatory Environment Sections 5.0 and 6.0 Various VECS/VSCs Under Analysis, Mitigation and Residual Effects Prediction Section 10.0 Environmental Management and Monitoring 12.0 Summary and Conclusions
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11.3 Socio-Economic Conditions and Recreational Opportunities	6.1 Socioeconomic Effects Assessment: *Local Economy* 6.2 Socioeconomic Effects Assessment: *Land Use* 6.3 Socioeconomic Effects Assessment: *Archaeological and Heritage Resources*

Table A1 Concordance Table

NSDEL Terms of Reference	EA Report
11.4 Air Quality	5.1 Environmental Effects Assessment: *Atmospheric Environment*
11.5 Noise Impacts	5.1 Environmental Effects Assessment: *Atmospheric Environment*
11.6 Surface Water Quality and Quantity	2.4 Construction activities 2.5 Highway Operation and Maintenance 5.2 Environmental Effects Assessment: *Groundwater Resources* 5.3 Environmental Effects Assessment: *Fish and Fish Habitat* 5.8 Environmental Effects Assessment: *Wetlands* 10.0 Environmental Management and Monitoring
11.7 Groundwater Quality and Quantity	5.2 Environmental Effects Assessment: *Groundwater Resources* 10.0 Environmental Management and Monitoring
11.8 Flora, Fauna and Habitat	5.3 Environmental Effects Assessment: *Fish and Fish Habitat* 5.4 Environmental Effects Assessment: *Rare Herpetiles* 5.5 Environmental Effects Assessment: *Rare Mammals and critical Habitat* 5.6 Environmental Effects Assessment: *Rare and Sensitive Birds* 5.7 Environmental Effects Assessment: *Rare Plants and Plant Communities* 5.8 Environmental Effects Assessment: *Wetlands* 10.0 Environmental Management and Monitoring
11.9 Forestry Resources	6.1 Socioeconomic Effects Assessment: *Local Economy*
11.10 Wetland Resources	5.8 Environmental Effects Assessment: *Wetlands* 10.0 Environmental Management and Monitoring
11.11 Fishery Resources	5.3 Environmental Effects Assessment: *Fish and Fish Habitat* 10.0 Environmental Management and Monitoring
11.12 Geological Resources	5.2 Environmental Effects Assessment: *Groundwater Resources* 5.3 Environmental Effects Assessment: *Fish and Fish Habitat*
11.13 Historical, Archaeological, Palaeontological and Architectural Resources	6.3 Socioeconomic Effects Assessment: *Archaeological and Heritage Resources*
11.14 Transportation	6.4 Socioeconomic Effects Assessment: *Transportation Infrastructure*
12.0 Residual Adverse Effects and Environmental Effects	9.0 Effects of the Environment on the Project
13.0 Proposed Compliance and Effects Monitoring Programs	Sections 5.0 and 6.0 various VECs/VSCs 10.0 Environmental Management and Monitoring 12.0 Summary and Conclusions
13. 1 Pre-Blast Survey	10.0 Environmental Management and Monitoring
13.2 Well Water Survey	10.0 Environmental Management and Monitoring
14.0 Public Information Program	11.0 Public Information Program

APPENDIX B

HYDROLOGY STUDY

HYDROTECHNICAL EVALUATION OF THE PROPOSED HIGHWAY 104 BYPASS ANTIGONISH, NOVA SCOTIA

PROJECT NO. 02029

REPORT TO

JACQUES WHITFORD ENVIRONMENT LIMITED

ON

HYDROTECHNICAL EVALUATION OF PROPOSED HIGHWAY 104 BYPASS ANTIGONISH, NOVA SCOTIA

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October 04, 2002

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  3.3 Un-named (0+600 to 0+850) 7
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  3.7 Un-named (2+600) 11
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1.0 INTRODUCTION

Hydro-Com Technologies Limited, acting at the request of Jacques Whitford Environment Limited has performed a hydrotechnical evaluation of an area in and around Antigonish, Nova Scotia as part of the Class II Environmental Assessment required for the proposed Nova Scotia Department of Transportation (NSDOT) Highway 104 Bypass of this area.

This report has been prepared solely for the project described above and contains a description of our methodologies, findings, and conclusions.

2.0 METHODOLOGY

The objective of the evaluation was to provide a general hydrologic, hydraulic, and water quality description of all surface water bodies in the vicinity of the proposed project. The scope of work for this evaluation consisted of the following components:

- review of the available mapping to assess the general site drainage patterns and to identify any significant watercourses,
- perform a site investigation and assessment of all the significant watercourses where they are crossed by the proposed highway bypass,
- determine the impacts to drainage, flooding, and water quality associated with the proposed highway bypass,
- provide an estimate of the effects of climate change on the regional hydrology, and
- provide a letter report on all of the findings including any recommendations.

3.0 EXISTING ENVIRONMENT

This section describes the hydrotechnical aspects of the existing environment at the proposed crossing sites, and is intended as a straightforward presentation of the information upon which subsequent analyses or interpretations are based. Information for each of the watercourses that will be crossed by the proposed alignment of the Highway 104 Bypass was collected through the review of available mapping, the performance of site inspections of all the watercourse crossings of the proposed alignment identified on the available mapping, and where applicable, site inspections of the watercourses identified at the crossing of the existing Highway 104. This section presents the relevant information collected from the various sources, while the interpretation of this information is presented in subsequent sections.

The surface water drainage patterns were reviewed based on; the 1:10,000 NSDOT alignment mapping, 1:50,000 topographic mapping (Maps 11 E/8, 11 E/9, 11 F/5, and 11 F/12, Nova Scotia), and the following 1:10,000 Nova Scotia orthographic series maps:

11 E/09 - W2
11 E/09 - W4
11 F/12 - U1
11 F/12 - U2
11 F/12 - U3
11 F/12 - R3
11 F/12 - R4

Initial investigation of the study area and the NSDOT mapping identified the following nineteen (19) watercourses (chainages shown in brackets refer to the mapping produced by the Nova Scotia Department of Transportation and/or chainage stakes located during the site inspections):

Un-named (0+100)
Un-named (0+275)
Un-named (0+600 to 0+850)
Un-named (1+400)
Un-named (2+075)
Un-named (2+420)
Un-named (2+600)
Un-named (3+910)
Un-named (4+150)
Un-named (5+490)
West River (5+700)
Un-named (6+950)
Un-named (8+150)
Un-named (9+160)
Un-named (10+250)
South River (11+150)
Un-named (12+350)
Un-named (13+600)
Un-named (14+580)

A hydrotechnical evaluation of the South River crossing (11+150) was not performed as this location has been previously studied ("Highway 104 Antigonish South River Impact Study" by Neill and Gunter Limited, 2001). Site inspections for the watercourses identified above (at the crossing locations of the proposed bypass alignment and if applicable at the existing Highway 104) were performed by Messrs.

Arisz, M.Sc.E., P.Eng, and Sharpe, M.Sc.E., P.Eng. of Hydro-Com Technologies Limited on August 26 and 27, 2002. The following sections describe the drainage patterns and basin characteristics for each of these watercourses.

Please note that the basin characteristics and field observations in the following sections are based on the existing drainage patterns (pre-construction). Any modifications to the drainage basins into and around the watercourses due to the construction of the proposed bypass roadway may affect the size of required hydraulic structures.

3.1 Un-named (0+100)

The watercourse at the proposed crossing collects surface flows from a small area south of the existing highway 104. As the proposed highway 104 bypass road is situated at the same location as the existing highway 104, the existing watercourse structure was investigated. The 1:10,000 scale mapping for this watercourse shows no residential or commercial properties within the watershed upstream of the proposed crossing.

The following observations were made during the site investigation (Photographs 1 and 2, Appendix A, refer):

- The structure is comprised of a rectangular timber cribwork culvert (approximately 1.8 m H by 1.5 m W) which is in good condition.
- No flow was observed in the culvert at the time of the inspection.
- The channel bottom upstream was comprised of rocks and gravel.
- The channel bottom downstream was comprised of dark soil and organics (indicating low flood flows).
- No high water marks or ice scarring were observed at the site.
- Main channel is poorly defined (indicating flows are likely intermittent).
- Channel upstream and downstream is vegetated with grasses (indicating low flood flows).
- Terrain is relatively flat without a well defined floodplain (indicating flood flows with small magnitudes).
- It appears that this culvert is for local drainage and may receive surface flows from the existing highway 104 roadway.

The following table presents the basin characteristics that were obtained from 1:10,000 scale mapping.

Table 1 - Un-named (0+100)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.205 km^2
Drainage Length [Channel Length]	0.74 km [0.59 km]
Average Basin Slope	3.3 %
Approximate Slope at Crossing Location	2.6 %
% Lakes	0.0 %

3.2 Un-named (0+275)

The watercourse at the proposed crossing collects surface flows from a small area south of the existing highway 104. As the proposed highway 104 bypass road is situated at the same location as the existing highway 104, the existing watercourse structure was investigated. The 1:10,000 scale mapping for this watercourse shows no residential or commercial properties within the watershed upstream of the proposed crossing.

The following observations were made during the site investigation (Photographs 3 and 4, Appendix A, refer):

- The structure is comprised of a concrete culvert (0.75 m diameter) which is in good shape, however, the last section of pipe downstream is separated and undercut.
- No flow was observed in the culvert at the time of the inspection.
- The channel bottom upstream was comprised of dark soil and organics (indicating low flood flows).
- The downstream end of the culvert is located approximately 0.60 m (2') above the channel bottom.
- No high water marks or ice scarring were observed at the site.
- Main channel is poorly defined (indicating flows are likely intermittent).
- Channel is vegetated with grasses.
- It appears that this culvert is for local drainage and may receive surface flows from the existing highway 104 roadway.
- Evidence of high flows in pipe (staining), therefore system may be "flashy".

The following table presents the basin characteristics that were obtained from1:10,000 scale mapping.

Table 2 - Un-named (0+275)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.070 km^2
Drainage Length [Channel Length]	0.47 km [0.32 km]
Average Basin Slope	4.9 %
Approximate Slope at Crossing Location	12.3 %
% Lakes	0.0 %

3.3 Un-named (0+600 to 0+850)

The watercourse at the proposed crossing collects surface flows from a large area south of the existing highway 104 and includes input from the watercourse described in section 3.4 (Un-named, 1+400). As the proposed highway 104 bypass road is situated at the same location as the existing highway 104, the existing watercourse structure was investigated. The 1:10,000 scale mapping for this watercourse shows some residential properties (on Addington Forks Road) within the watershed upstream of the proposed crossing.

The following observations were made during the site investigation (Photographs 5 through 8, Appendix A, refer):

- The watercourse is an existing wetland habitat located adjacent to the existing highway 104 with a culvert under the roadway located at approximately 0+750.
- The existing structure is comprised of a timber cribwork culvert (1.5 m H by 1.2 m W) in fair condition (slight sagging of roof in the middle of the culvert).
- No flow was observed in the culvert at the time of the inspection.
- No high water marks or ice scarring were observed at the site.
- Upstream wetland habitat is significant size.
- Channel is highly vegetated upstream and downstream (indicating flood flows with small magnitudes).
- Terrain is relatively flat upstream and downstream.
- Standing water depth at time of inspection was between 0.10 to 0.30 m.

The following table presents the basin characteristics that were obtained from 1:10,000 scale mapping.

Table 3 - Un-named (0+600 to 0+850)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	1.140 km^2
Drainage Length [Channel Length]	1.64 km [1.34 km]
Average Basin Slope	1.5 %
Approximate Slope at Crossing Location	~0.5 %
% Lakes	0.0 %

3.4 Un-named (1+400)

The watercourse at the proposed crossing collects surface flows from a small area between trunk 4 and the existing highway 104. As the proposed highway 104 bypass road is situated at the same location as the existing highway 104, the existing watercourse structure was investigated. The 1:10,000 scale mapping for this watercourse shows some residential and commercial properties within the watershed upstream of the proposed crossing.

The following observations were made during the site investigation (Photographs 9 and 10, Appendix A, refer):

- The existing structure is comprised of a square timber cribwork culvert (1.2 m by 1.2 m) in good condition.
- No flow was observed in the culvert at the time of the inspection.
- No high water marks were observed at the site.
- Channel upstream is vegetated with grasses (indicating flood flows with small magnitudes).
- It appears that this culvert is for local drainage and may receive surface flows from the existing highway 104 roadway.

The following table presents the basin characteristics that were obtained from 1:10,000 scale mapping.

Table 4 - Un-named (1+400)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.112 km^2
Drainage Length [Channel Length]	0.22 km [0.21 km]
Average Basin Slope	4.9 %
Approximate Slope at Crossing Location	3.8 %
% Lakes	0.0 %

3.5 Un-named (2+075)

The watercourse at the proposed crossing collects surface flows from: an area north of trunk 4, between trunk 4 and highway 104, and between highway 104 and Addington Forks Road. This watercourse is not crossed by the proposed 104 bypass roadway but would be crossed by a proposed off-ramp. An investigation of this watercourse was therefore performed at the existing crossing of the Addington Forks Road. The 1:10,000 scale mapping for this watercourse shows residential properties within the watershed upstream of the proposed crossing (note that some residences on Addington Forks Road will be moved for the proposed highway).

The following observations were made during the site investigation (Photographs 11 and 12, Appendix A, refer):

- The existing structure is comprised of two (2) offset corrugated steel culverts (0.750 m diameter) in fair condition.
- No flow was observed in the culverts at the time of the inspection.
- No ice scarring was observed at the site.
- Channel upstream and downstream is vegetated with grasses (indicating flood flows with small magnitudes).
- Terrain is relatively flat without a well defined floodplain (indicating flood flows with small magnitudes).
- High water mark indicated by rust line located at half depth of upper culvert.
- The lower culvert was approximately half full of silt and sand.

The following table presents the basin characteristics that were obtained from1:10,000 scale mapping.

Table 5 - Un-named (2+075)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.243 km^2
Drainage Length [Channel Length]	0.79 km [0.79 km]
Average Basin Slope	1.1 %
Approximate Slope at Crossing Location	1.2 %
% Lakes	0.0 %

3.6 Un-named (2+420)

The watercourse at the proposed crossing collects surface flows from an area south of the existing highway 104 and east of Addington Forks Road as well as the drainage from the watercourse described in section 3.5 (Un-named, 2+075). The 1:10,000 scale mapping for this watercourse indicates that there are both residential and commercial properties within the watershed upstream of the proposed crossing.

The following observations were made during the site investigation (Photographs 13 through 15, Appendix A, refer):

- Terrain is relatively flat without a well defined floodplain.
- No flow at the time of inspection.
- Channel width approximately 1.5 to 2.0 m.
- Stable rock size, d_{50}, approximately 0.10 m.
- Positive chainage bank at proposed crossing location is fairly steep.
- Negative chainage bank at proposed crossing location is shallow.
- No evidence of erosion in the floodplain.
- No evidence of ice scour or scarring, however, believe this location to have ice jamming potential.

The following table presents the basin characteristics that were obtained from 1:10,000 scale mapping.

Table 6 - Un-named (2+420)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.395 km^2
Drainage Length [Channel Length]	1.19 km [1.19 km]
Average Basin Slope	1.5 %
Approximate Slope at Crossing Location	2.7 %
% Lakes	1.0 %

3.7 Un-named (2+600)

The watercourse at the proposed crossing collects surface flows from a small area south of the existing highway 104. The 1:10,000 scale mapping for this watercourse indicates that there are no residential properties within the watershed upstream of the proposed crossing.

The following observations were made during the site investigation (Photographs 16 and 17, Appendix A, refer):

- Main channel is not defined (indicating flows are likely intermittent).
- Channel is vegetated with grasses (indicating flood flows with small magnitudes).
- Terrain is relatively flat without a well defined floodplain (indicating flood flows with small magnitudes).
- No flow at the time of inspection.
- No hydrotechnical concern.

The following table presents the basin characteristics that were obtained from 1:10,000 scale mapping.

Table 7 - Un-named (2+600)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.139 km^2
Drainage Length [Channel Length]	0.45 km [0.19 km]
Average Basin Slope	3.5 %
Approximate Slope at Crossing Location	3.0 %
% Lakes	0.0 %

3.8 Un-named (3+910)

The watercourse at the proposed crossing collects surface flows from a small area south of the existing highway 104 and west of trunk 7. The 1:10,000 scale mapping for this watercourse shows some residential properties (Tamara Drive subdivision) within the watershed upstream of the proposed crossing.

The following observations were made during the site investigation (Photographs 18 and 19, Appendix A, refer):

- Channel upstream and downstream is vegetated with grasses (indicating flood flows with small magnitudes).
- No flow at the time of inspection.
- Channel width approximately 1.0 m (man-made ditch with a dirt bottom).
- No hydrotechnical concern.

The following table presents the basin characteristics that were obtained from 1:10,000 scale mapping.

Table 8 - Un-named (3+910)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.127 km^2
Drainage Length [Channel Length]	0.72 km [0.12 km]
Average Basin Slope	2.9 %
Approximate Slope at Crossing Location	2.5 %
% Lakes	0.0 %

Existing Structure Inspection

A site inspection was performed on the structure which conveys flows from this watercourse crossing and the watercourse crossing described in section 3.9 (Un-named, 4+150) under the existing Highway 104. The following observations were made during the site inspection (Photographs 20 through 22, Appendix A, refer):

- The structure is comprised of a square timber cribwork culvert (0.9 m by 0.9 m) in a fair to poor condition (slight lean to structure).

- Little or no flow was observed in the culvert at the time of the inspection.
- Standing water in the culvert approximately 0.45 m at upstream end.
- The downstream end of the culvert was mostly submerged at the time of the inspection.
- A storm culvert was located draining to the downstream side of this structure.

3.9 Un-named (4+150)

The watercourse at the proposed crossing collects surface flows from an area south of the existing highway 104. The 1:10,000 scale mapping for this watercourse indicates that there are residential properties within the watershed upstream of the proposed crossing (trunk 7, and Tamara Drive).

The following observations were made during the site investigation (Photographs 23 through 26, Appendix A, refer):

- Proposed crossing is located at same spot as an existing dirt road which has an existing structure.
- Existing structure at upstream end is comprised of two (2) offset corrugated steel culverts (0.6 m diameter).
- High water marks of upstream culverts indicated by rust line located at half depth of upper culvert.
- Existing structure at downstream end is comprised of a cut-off oil tank.
- Channel downstream appears to have been man-made.
- Channel upstream is highly vegetated (indicating flood flows with small magnitudes).
- Terrain is relatively flat without a well defined floodplain.
- No flow at the time of inspection.
- Channel width approximately 3.0 m downstream.
- Standing water depth at time of inspection was approximately 0.30 m.
- No evidence of erosion in the floodplain.
- No evidence of ice scour or scarring.
- Inspection of a structure (corrugated steel culvert, 0.6 m diameter) located under a drive-way approximately 40 m upstream of proposed crossing indicated some overtopping.

The following table presents the basin characteristics that were obtained from:10,000 scale mapping.

Table 9 - Un-named (4+150)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.493 km^2
Drainage Length [Channel Length]	1.27 km [0.98 km]
Average Basin Slope	2.0 %
Approximate Slope at Crossing Location	1.3 %
% Lakes	0.0 %

3.10 Un-named (5+490)

The watercourse at the proposed crossing collects surface flows from a small area south of the existing highway 104 and west of the Kell Road. The 1:10,000 scale mapping for this watercourse indicates there are residential properties within the watershed upstream of the proposed crossing (Kell Road).

The following observations were made during the site investigation (Photograph 27, Appendix A, refers):

- Main channel is poorly defined (indicating flows are likely intermittent) and appears to be local drainage only.
- Channel is highly vegetated with grasses and moss (indicating flood flows with small magnitudes).
- Terrain is relatively flat without a well defined floodplain (indicating flood flows with small magnitudes).
- No flow at the time of inspection.
- No hydrotechnical concern.

The following table presents the basin characteristics that were obtained from 1:10,000 scale mapping.

Table 10 - Un-named (5+490)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.366 km^2
Drainage Length [Channel Length]	0.94 km [0.88 km]
Average Basin Slope	2.4 %
Approximate Slope at Crossing Location	0.8 %
% Lakes	0.0 %

3.11 West River (5+700)

The watercourse at the proposed crossing collects surface flows from a significantly sized watershed that extends to the James River (north of the existing highway 104) and to Donny Brook (south of the existing highway 104). The 1:50,000 and 1:10,000 scale mapping for this watercourse indicates that there is a large number of residential and commercial properties within the watershed upstream of the proposed crossing.

The following observations were made during the site investigation (Photographs 28 through 31, Appendix A, refer):

- Good flow at the time of inspection (unmeasured).
- Channel width approximately 25 m.
- Water depth at time of inspection was approximately 0.30 m at the centre of the channel.
- Stable channel with stable rock size, d_{50}, approximately 0.075 m.
- Negative chainage bank at proposed crossing location is fairly steep.
- Floodplain exists upstream of crossing location on negative chainage side with competent vegetation (indicating no significant flows or ice movement).
- Floodplain exists at crossing location on positive chainage side with competent vegetation.
- Alignment of proposed highway is perpendicular to channel.
- No evidence of erosion in the floodplain.
- No evidence of ice scour or scarring.
- No high water marks located at proposed crossing location.
- Due to the width of the crossing and the steep bank on the negative chainage side, recommend a bridge structure at this location.

The following table presents the basin characteristics that were obtained from 1:50,000 scale mapping and confirmed using 1:10,000 scale mapping.

Table 11 - West River (5+700) Basin Characteristics Upstream of Proposed Crossing	
Parameter	**Value**
Drainage Area	330.6 km^2
James River Drainage Length [James River Channel Length]	32.35 km [31.07 km]
Ohio River/Donny Brook Drainage Length [Ohio River/Donny Brook Channel Length]	43.37 km [41.59 km]
James River Average Basin Slope	0.89 %
Ohio River/Donny Brook Average Basin Slope	0.51 %
Approximate Slope at Crossing Location	~0.33 %
% Lakes	0.56 %

3.12 Un-named (6+950)

The watercourse at the proposed crossing collects surface flows from a small area south of the existing highway 104 and east of Beech Hill Road. The 1:10,000 scale mapping for this watercourse shows that there are some residential properties within the watershed upstream of the proposed crossing (at existing highway 104).

The following observations were made during the site investigation (Photographs 32 through 34, Appendix A, refer):

- Main channel is well defined and incised approximately 0.5 m (indicating good flows).
- Channel is steep at proposed crossing location
- No flow at the time of inspection.
- Channel width approximately 0.9 m.
- Stable rock size, d_{50}, approximately 0.05 m with some larger moss covered rocks.
- Floodplain not well defined and vegetated on both sides of channel.
- No evidence of ice scour or scarring.
- System may be "flashy".

The following table presents the basin characteristics that were obtained from1:10,000 scale mapping.

Table 12 - Un-named (6+950)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.207 km^2
Drainage Length [Channel Length]	0.81 km [0.53 km]
Average Basin Slope	4.2 %
Approximate Slope at Crossing Location	3.5 %
% Lakes	0.0 %

Existing Structure Inspection

A site inspection was performed on the structure which conveys flows from this watercourse under Beech Hill Road (located downstream of the proposed crossing location). The following observations were made during the site inspection (Photographs 35 through 37, Appendix A, refer):

- The structure is comprised of a corrugated steel culvert (0.9 m diameter) in fair condition.
- No flow was observed in the culvert at the time of the inspection.
- The channel bottom both upstream and downstream was comprised of dark soil and organics (indicating low flood flows).
- High water mark in culvert indicated by rust line at approximately 40% depth.
- This structure also receives flows from an area north of highway 104 which travels under the highway via a timber cribwork culvert (0.6 m by 0.60 m). This culvert was found to be in poor condition with the downstream culvert section having failed

3.13 Un-named (8+150)

The watercourse at the proposed crossing collects surface flows from a large area south of the existing highway and east of Beech Hill Road as well as the drainage from the watercourse described in section 3.14 (Un-named, 9+160). The 1:10,000 scale mapping for this watercourse shows some residential or commercial properties within the watershed upstream of the proposed crossing (at existing highway 104).

The following observations were made during the site investigation (Photographs 38 and 39, Appendix A, refer):

- No visible flow at the time of inspection.
- Channel width approximately 8.0 to 10.0 m .
- Water depth at time of inspection was between 0.3 and 0.6 m.
- Channel bottom comprised of silts and sands (indicating low flood flows)
- Both positive and negative chainage banks at proposed crossing location are fairly steep, with positive chainage side clear-cut up to edge of watercourse (potential for erosion and sediments into watercourse).
- No evidence of ice scour or scarring.
- Wide channel and steep banks therefore recommend a span structure or bridge for this crossing location.
- A riffle section is located approximately 60 m downstream of the proposed crossing location.

The following table presents the basin characteristics that were obtained from 1:10,000 scale mapping.

Table 13 - Un-named (8+150)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	3.153 km^2
Drainage Length [Channel Length]	3.71 km [3.49 km]
Average Basin Slope	2.3 %
Approximate Slope at Crossing Location	1.2 %
% Lakes	0.0 %

Existing Structure Inspection

A site inspection was performed on the structure which conveys flows from this watercourse under the existing Highway 104 (located downstream of the proposed crossing). The following observations were made during the site inspection (Photographs 40 and 41, Appendix A, refer):

- The structure is comprised of a cast in place concrete culvert (1.8 m by 1.8 m) in good condition.
- No flow was observed in the culvert at the time of the inspection.
- The channel bottom upstream was comprised of dark soil and organics (indicating low flood flows).
- The channel was well vegetated both upstream and downstream of the structure, with a good wetland habitat located immediately upstream of the structure.
- Recommended increased sediment control at the proposed crossing location to minimize any impact on the downstream wetland.

3.14 Un-named (9+160)

The watercourse at the proposed crossing collects surface flows from a small area around the existing highway 104. The 1:10,000 scale mapping for this watercourse indicates that there are both residential and commercial properties within the watershed upstream of the proposed crossing.

The following observations were made during the site investigation (Photographs 42 and 43, Appendix A, refer):

- Main channel is poorly defined (indicating flows are likely intermittent).
- Channel is vegetated with grasses and moss (indicating flood flows with small magnitudes).
- Terrain is relatively flat without a well defined floodplain (indicating flood flows with small magnitudes).
- No flow at the time of inspection.
- No hydrotechnical concern.

The following table presents the basin characteristics that were obtained from 1:10,000 scale mapping.

Table 14 - Un-named (9+160)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.219 km^2
Drainage Length [Channel Length]	0.66 km [0.35 km]
Average Basin Slope	5.3 %
Approximate Slope at Crossing Location	1.8 %
% Lakes	0.0 %

3.15 Un-named (10+250)

The watercourse at the proposed crossing collects surface flows from a small area south of the existing highway 104. The 1:10,000 scale mapping for this watercourse shows no residential or commercial properties within the watershed upstream of the proposed crossing.

The following observations were made during the site investigation (Photographs 44 and 45, Appendix A, refer):

- Main channel is well defined and incised approximately 0.5 m (indicating good flood flows).
- No flow at the time of inspection.
- Channel width approximately 1.0 m .
- Channel is steep at the proposed crossing location.
- Stable rock size, d_{50}, approximately 0.15 m.
- Both positive and negative chainage banks at proposed crossing location are fairly steep.
- System may be "flashy".

The following table presents the basin characteristics that were obtained from 1:10,000 scale mapping.

Table 15 - Un-named (10+250)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.148 km^2
Drainage Length [Channel Length]	0.65 km [0.28 km]
Average Basin Slope	6.4 %
Approximate Slope at Crossing Location	6.7 %
% Lakes	0.0 %

Existing Structure Inspection

A site inspection was performed on two (2) structures located downstream of the proposed crossing; the first structure conveys flows under the existing Highway 104 while the second structure conveys the flows under a secondary road. The following observations were made during the site inspection (Photographs 46 through 49, Appendix A, refer):

Existing Highway 104 Structure

- The structure is comprised of a cast in place concrete culvert (1.2 m by 1.2 m) on the upstream end, with a section of corrugated steel culvert (1.35 m diameter) at the downstream end.
- Rust mark on downstream end culvert indicates low flows, however, tar coating on inside of pipe has worn to the half pipe depth (indicating potential "flashy" flows).
- Channel at upstream end of structure comprised of large rock, d_{50} approximately 0.05 m with some larger rocks (0.1 m) located in the ditch alongside the existing highway.
- Steep banks off existing highway 104 both upstream and downstream of structure, with signs of erosion and large rock.

Secondary Road Structure

- The structure is comprised of a cast in place concrete arch culvert (2.25 m H by 1.2 m W).
- The floor of the structure is deteriorating which may allow flows to travel underneath the structure.
- No flow was observed in the culvert at the time of the inspection.

3.16 Un-named (12+350)

The watercourse at the proposed crossing collects surface flows from a small area north of the existing highway 104. The 1:10,000 scale mapping for this watercourse shows no residential properties within the watershed upstream of the proposed crossing. The proposed crossing location was not inspected, however, the existing culvert located downstream under a secondary road was.

The following observations were made during the site investigation (Photographs 50 through 52, Appendix A, refer):

- The existing structure under the secondary road is comprised of a timber cribwork culvert (0.9 m by 0.9 m) on the upstream side, with a cast in place concrete culvert (0.9 m by 0.9 m) on the downstream side.
- No flow was observed in the culvert at the time of the inspection.
- Main channel upstream is poorly defined (indicating flows are likely intermittent).
- Culvert appears to be for local drainage only.
- Erosion measures including rip-rap placed downstream of structure between secondary road and existing highway 104.
- Storm sewer culverts enter ditch between roads from both directions.
- The existing structure under highway 104 is comprised of a concrete culvert (1.2 m diameter) on the upstream side, with a timber cribwork culvert (0.75 m by 0.75 m) on the downstream side.

The following table presents the basin characteristics that were obtained from1:10,000 scale mapping.

Table 16 - Un-named (12+350)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.108 km^2
Drainage Length [Channel Length]	0.42 km [0.42 km]
Average Basin Slope	~3.0 %
Approximate Slope at Crossing Location	1.9 %
% Lakes	0.0 %

3.17 Un-named (13+600)

The watercourse at the proposed crossing collects surface flows from a small area north of the existing highway 104. The 1:10,000 scale mapping for this watercourse shows no residential or commercial properties within the watershed upstream of the proposed crossing.

The following observations were made during the site investigation (No photographs available):

- Main channel is poorly defined (indicating flows are likely intermittent).
- Channel is vegetated with grasses and moss (indicating flood flows with small magnitudes).
- Terrain is relatively flat without a well defined floodplain (indicating flood flows with small magnitudes).
- No flow at the time of inspection.

The following table presents the basin characteristics that were obtained from 1:10,000 scale mapping.

Table 17 - Un-named (13+600)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.062 km^2
Drainage Length [Channel Length]	0.30 km [0.06 km]
Average Basin Slope	1.3 %
Approximate Slope at Crossing Location	~0.5 %
% Lakes	0.0 %

Existing Structure Inspection

A site inspection was performed on the structure which conveys flows from this watercourse under the existing Highway 104 (downstream of the proposed crossing). The following observations were made during the site inspection (Photographs 53 through 55, Appendix A, refer):

- The structure is comprised of a cast in place concrete culvert (0.6 m by 0.6 m).
- No flow was observed in the culvert at the time of the inspection.
- The channel bottom upstream was comprised of dark soil and organics (indicating low flood flows).
- No high water marks or ice scarring were observed at the site.

3.18 Un-named (14+580)

The watercourse at the proposed crossing collects surface flows from a small area south of existing highway 104. As the proposed highway 104 bypass road is situated at the same location as the existing highway 104, the existing watercourse structure was investigated. The 1:10,000 scale mapping for this watercourse shows no residential properties within the watershed upstream of the proposed crossing.

The following observations were made during the site investigation (Photographs 56 and 57, Appendix A, refer):

- The structure is comprised of a cast in place concrete culvert (0.6 m by 0.6 m).
- No flow was observed in the culvert at the time of the inspection.
- The channel bottom upstream was comprised of dark soil and organics (indicating low flood flows).
- Staining due to groundwater infiltration was observed at the downstream end of the culvert.
- No high water marks or ice scarring were observed at the site.
- Channel upstream is vegetated with grasses (indicating flood flows with small magnitudes).
- Terrain is relatively flat without a well defined floodplain (indicating flood flows with small magnitudes).
- No evidence of ice scour or scarring.

The following table presents the basin characteristics that were obtained from1:10,000 scale mapping.

Table 18 - Un-named (14+580)
Basin Characteristics Upstream of Proposed Crossing

Parameter	Value
Drainage Area	0.236 km^2
Drainage Length [Channel Length]	1.00 km [0.71 km]
Average Basin Slope	2.2 %
Approximate Slope at Crossing Location	~1.0 %
% Lakes	0.0 %

4.0 IMPACT ASSESSMENT, MITIGATION AND MONITORING

Since surface water supplies are sensitive to environmental effects resulting from development activities, any major development in a watershed can pose a potential water quality hazard. Surface water resources are hydraulically linked to groundwater resources and aquatic habitat. Surface water quality can be directly affected by the volume and quality of groundwater flowing to the surface water; while conversely, surface water quality and quantity may affect groundwater quality and quantity. Construction activities may alter existing overland drainage patterns and result in the transport of suspended solids to the nearest stream or wetland.

The key environmental issues for surface water resources from a linear development include:

- interference with drainage,
- interference with the local flood regime, and
- degradation of the water quality of surface water resources.

4.1 Drainage

The potential interference with the local drainage by the construction and operation of the proposed new highway may consist of the blockage or alteration of existing drainage patterns or the creation of new drainage channels over previously undisturbed terrain.

Based on the field inspection, all of the watercourses along the proposed road alignment are well defined with all of the existing local drainage concentrated through the channels. However, since the majority of the watercourses have small drainage areas, the additional drainage area from the proposed highway (road surface, median, ditches, etc.) becomes significant (see areas and volumes of runoff in Table 19, section 4.3.2). Therefore the design of the structures should account for the additional drainage area and associated flows.

4.2 Flooding

The potential interference with the local flood regime by the construction of the proposed new highway would consist of the initiation or aggravation of local flooding (especially at watercourse crossings that: have large drainage basins, steep channel slopes, and have significant floodplains). None of the proposed crossing locations showed signs of active ice movement (ice scour, erosion, scarring, significant debris in channel) and there is limited development in or near the floodplain of most watercourses that could be affected. However, several of the crossing locations were assessed as having the potential for ice or debris jam which may endanger the stability of the roadway embankment. Based on the field inspections, the following watercourses were identified as being "flashy" (due to steep channel at crossing, large stable rock) and/or had steep banks at the crossing with no floodplain. These sites would have the potential for the initiation of an ice or debris jam especially with the additional flows from the proposed highway.

- Un-named 0+275
- Un-named 2+420
- Un-named 8+150
- Un-named 10+250

4.3 Water Quality

The potential impacts of the construction and operation of the proposed new highway on the water quality of local surface water resources may consist of the entrance of sediment laden runoff or runoff containing contaminants (salt and/or hydrocarbons) into watercourses. The entrance of sediment laden runoff from the roadway right-of-way into watercourses is expected to primarily occur during construction, while the entrance of runoff containing contaminants is expected to occur primarily during the operation of the highway (sanding and salting operations during the winter and spring seasons and oil and gasoline drips from traffic on the proposed roadways).

4.3.1 Sediment Laden Runoff

The potential for the entrance of sediment laden runoff is minimal in the majority of the watercourses as the general terrain outside of the floodplain and riparian zone is relatively flat. However, steep banks were found at the following crossing locations which could lead to sediment laden runoff entering the watercourses;

- Un-named 2+420
- West River 5+700
- Un-named 8+150
- Un-named 10+250

Note that the steep bank on the positive chainage side of the watercourse at Un-named 8+150 was found to be clear-cut all the way to the watercourse edge. This lack of natural vegetation could lead to increased amounts of bank erosion and sediment load entering the watercourse. In addition, a good wetland habitat exists downstream of this crossing location (upstream of the existing structure under highway 104) which could be adversely affected by sediments.

The use of standard erosion and sediment control measures is expected to adequately mitigate the effects of sediment laden runoff on nearby surface water sources of watercourses. However, it is recommended that the watercourses identified above as having steep banks (especially the watercourse at Un-named 8+150) should have an augmented level of erosion and sediment control measures.

4.3.2 Runoff Containing Contaminants

To assess the significance of surface runoff from the proposed new highway, the annual volume of surface runoff from the proposed driving surface within each watercourse was estimated and compared to the mean annual flow in each of the impacted watercourses. The annual volume of surface runoff from the proposed driving surface was estimated using: a design road width of 60.0 m (includes roadway surface, median area, and roadside ditch), lengths of highway draining to each watercourse (assuming highway will follow the natural topography), a mean annual precipitation amount of 1,200 mm/year (MacLaren Atlantic Limited, 1980), and a runoff coefficient of 1.0, since all precipitation on the highway driving surface ends up as surface runoff. The mean annual flow in each of the watercourses was estimated using the drainage area (as measured from the 1:50,000 scale mapping) and a mean annual runoff of 900 mm/year (MacLaren Atlantic Limited, 1980). The results from the assessment are presented in Table 19.

Based on the results presented in Table 19, the volume of runoff from the driving surfaces of the proposed new highway ranges between 0.05 and 56.6 % of the mean annual flow in the impacted watercourses. Only those locations identified as having a runoff volume to mean annual runoff greater than 10 % are believed to have a potential impact on the water quality of a watercourse. A total of 13 watercourses are identified in Table 19 as satisfying this criteria. Therefore, the sensitivity of the aquatic habitat downstream of these crossings to the above water quality impacts should be reviewed.

Table 19 - Surface Runoff Estimates and Comparison					
Crossing (Location)	**Roadway Area (m^2)**	**Annual Runoff (m^3)**	**Watershed Area (km^2)**	**Annual Flow (m^3)**	**%**
Un-named (0+100)	24,000	28,800	0.205	184,500	15.6
Un-named (0+275)	12,000	14,400	0.070	63,000	22.9
Un-named (0+600 to 0+850)	93,000	111,600	1.140	1,026,000	10.9
Un-named (1+400)	36,000	43,200	0.112	100,800	13.1
Un-named (2+075)	36,000	43,200	0.243	218,700	19.8
Un-named (2+420)	18,000	21,600	0.395	355,500	6.1
Un-named (2+600)	27,000	32,400	0.139	125,100	25.9
Un-named (3+910)	9,000	10,800	0.127	114,300	9.4
Un-named (4+150)	36,000	43,200	0.493	443,700	9.7
Un-named (5+490)	42,000	50,400	0.366	329,400	15.3
West River (5+700)	126,000	151,200	330.638	297,574,000	0.05
Un-named (6+950)	36,000	43,200	0.207	186,300	23.2
Un-named (8+150)	156,000	187,200	3.153	2,837,700	6.6
Un-named (9+160)	48,000	57,600	0.219	197,100	29.2
Un-named (10+250)	24,000	28,800	0.148	133,200	21.6
Un-named (12+350)	30,000	36,000	0.108	97,200	37.0
Un-named (13+600)	18,000	21,600	0.062	55,800	56.6
Un-named (14+580)	42,000	50,400	0.236	212,400	23.7

5.0 CLIMATE CHANGE ASSESSMENT

The following climate information is extracted from a background paper titled "Water Sector: Vulnerability and Adaptation to Climate Change" which was presented during a Canadian Society of Civil Engineering conference held in Moncton, New Brunswick, 11 to 12 May, 2000. This document was prepared with support from the Climate Change Action Fund, National Resources Canada with authors from Global Change Strategies International Inc. (GCSI) and the Atmospheric Environment Service, Environment Canada.

The above document discusses the climate trends associated with an increase in the global mean temperature due to increased greenhouse gases in the atmosphere (particularly carbon dioxide, CO_2). The trends are based on General Circulation Models or Global Climate Models (GCM's) that have been developed in Canada, U.S.A., U.K., and Germany. These models anticipate that the concentration of CO_2 in the atmosphere will double between the year 2000 and the year 2050. The following relevant statements that were extracted from the document are presented below:

- For a doubled CO_2 atmosphere, by the second half of the coming century, temperature increases for summers, over Canada, as projected would average about 4 °C. For winter months (Dec, Jan, Feb) increases of 6 °C or more are projected for most of central Canada, with slightly lower values in the east and west.
- A winter precipitation increase of 0 to 20% is projected for Atlantic Canada.
- In summer only small increases in precipitation are projected for Atlantic Canada.
- Nationally, precipitation has increased 1.7% of the mean per decade over the period 1948 to 1985.
- No analyses of Canadian data are available of trends in very short duration (minutes to hours) heavy rain events which cause city street flooding, sewer overflows, erosion and flash floods, and landslides, but some analyses of heavy one-day events have been undertaken. These show that there has been an increase in precipitation in heavy events in Atlantic Canada.
- Model results indicate that there will be an increased frequency of heavy one-day rains in a doubled CO_2 climate, with return periods halved, e.g. a 20 year return period rainfall becomes a 10 year event.
- The Canadian GCM indicates that in a doubled CO_2 world, the number of weak to moderate winter storms in the northern hemisphere would decrease but the number of very severe storms would increase.
- If the frequency of short duration high precipitation intensities increase as projected, then greater soil erosion and sedimentation is likely, and more pollutants will be washed into rivers and lakes due to urban runoff.

The above information, in particular the change in the return period of storm events, should be considered during the design of the watercourse structures.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the field observations that were performed as part of this study, and assuming normal standards are used during the design of the hydraulic structures (this includes addressing the high risk for the initiation of an ice or debris jam at the identified watercourses and the accommodation of increased storm flows due to highway runoff and global warming), no significant hydraulic changes are expected either during or after construction of the new highway.

Based on experience with erosion and sediment control measures in Eastern Canada, it is recommended that these measures be designed to function to the applicable water quality limits during a 1 in 2 year return period storm event. Structures are designed to withstand a 1 in 100 year return period event without incurring significant damage.

Smaller culverts are based on a 1 in 100 year return period under worst case conditions (frozen ground conditions). For 100 Series Highways, a minimum cross culvert size of 900 mm diameter is used, which often is considerably larger than the design requires.

For larger structures, including bridges, the design is based on a 1 in 100 year event without incurring significant damage. Consideration is also given to the width of the existing watercourse, upstream and downstream structure dimensions, fish passage requirements, anticipated increases in runoff, and field observations that includes comments from local residents and NSTPW maintenance field staff on the capacity of existing structures under recent 1:100 storm events.

Due to the wide channel width and the steep negative chainage bank that exists at the West River (5+700) crossing, it is recommended that a free-spanning structure be considered at this location. As the crossing at Un-named 8+150 is a good habitat and steep banks also exist at this location, it is recommended that a spanning structure (arch-span culvert, bridge, etc.) be considered at this location.

The percentage of runoff containing contaminants to the mean annual runoff at 13 of the watercourse crossings were greater than 10 % indicating a potential impact on the aquatic habitat downstream of these location. It is recommended that the aquatic habitat downstream of these locations be reviewed to assess the requirements for contaminant mitigation measures at the crossing.

7.0 SIGNATURE

This report is an accurate reflection of the field conditions noted during the site inspection performed on August 26 and 27, 2002 by Messers Arisz, M.Sc.E., P.Eng., and Sharpe, M.Sc.E., P.Eng. of Hydro-Com Technologies Limited.

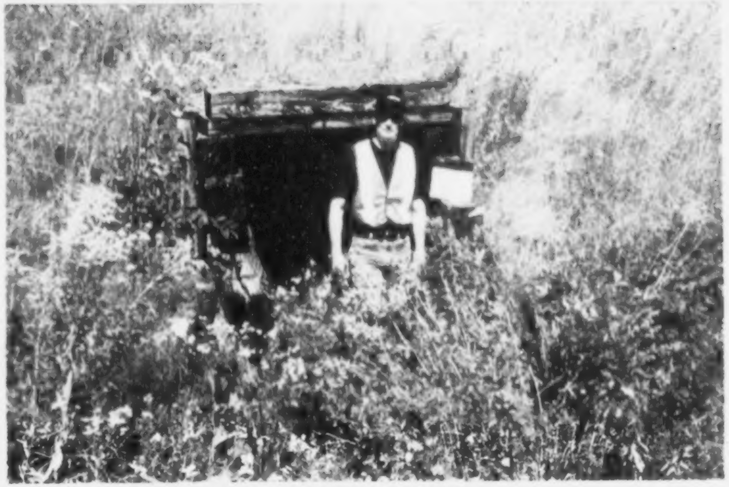
Robert B. Sharpe, M.Sc.E., P.Eng.

REFERENCES

MacLaren Atlantic Limited. 1980. Regional Flood Frequency Analysis for Mainland Nova Scotia Streams

Appendix A

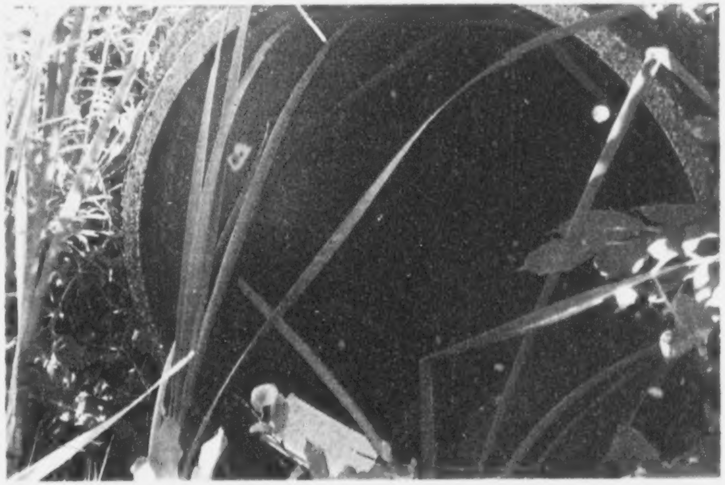
Site Photographs



Photograph 1 – Un-named 0+100
Existing timber culvert upstream side

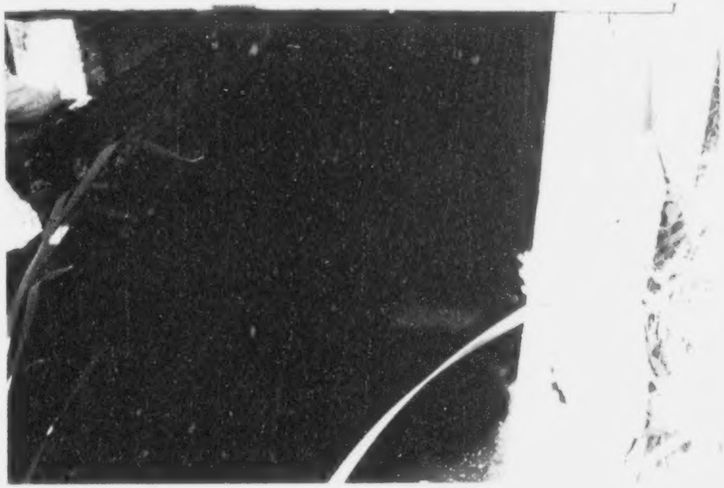
Photograph 2 – Un-named 0+100
Local drainage culvert to upstream side

Photograph 3 – Un-named 0+275
Existing concrete culvert upstream side

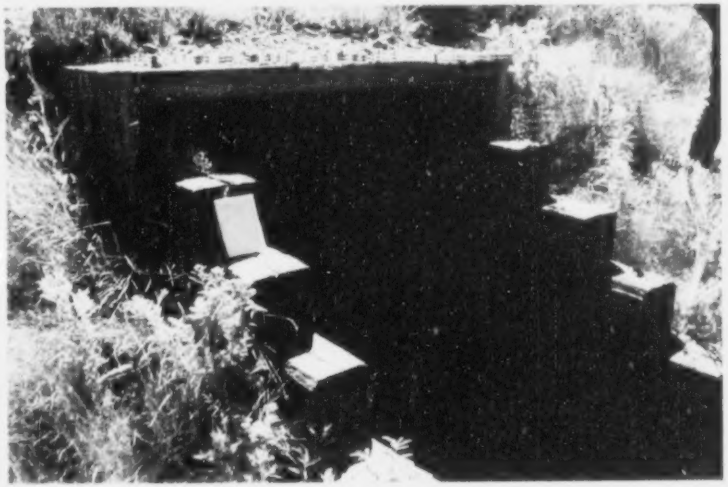


Photograph 4 – Un-named 0+275
Existing concrete culvert downstream side

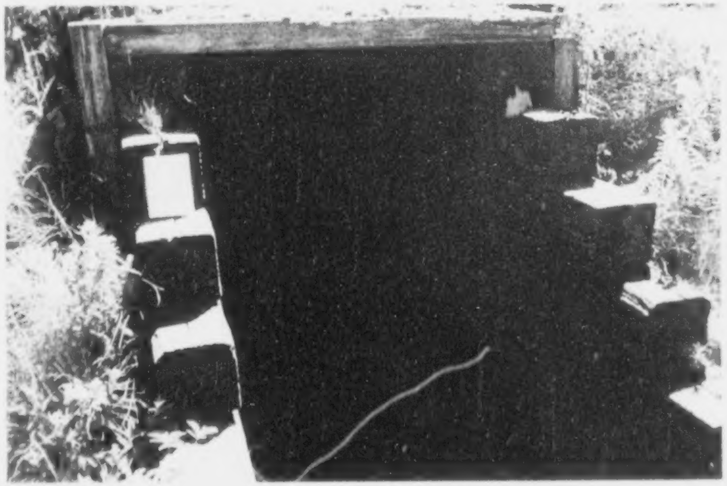
Photograph 5 – Un-named 0+600 to 0+850
Existing timber culvert upstream side at 0+750



Photograph 6 – Un-named 0+600 to 0+850
Existing timber culvert upstream side at 0+750

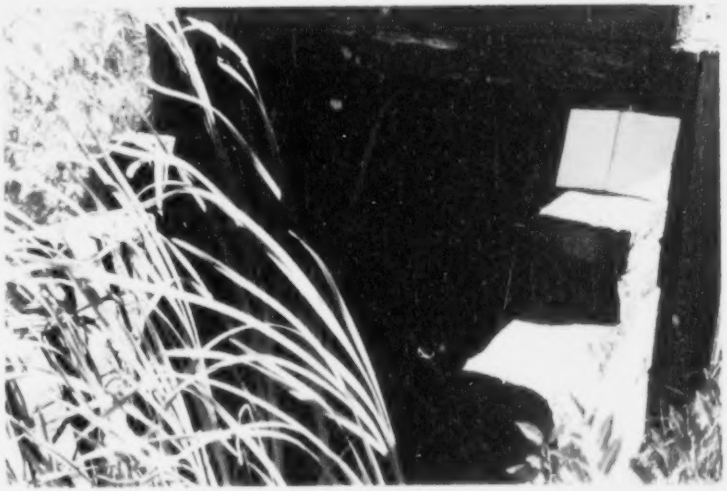


Photograph 7 – Un-named 0+600 to 0+850
Existing timber culvert downstream side at 0+750



Photograph 8 – Un-named 0+600 to 0+850
Existing timber culvert downstream side at 0+750

Photograph 9 – Un-named 1+400
Existing timber culvert downstream side



Photograph 10 – Un-named 1+400
Existing timber culvert upstream side

Photograph 11 – Un-named 2+075
Existing culverts upstream side

Photograph 12 – Un-named 2+075
Existing culverts downstream side

Photograph 13 – Un-named 2+420
Channel at crossing location looking downstream

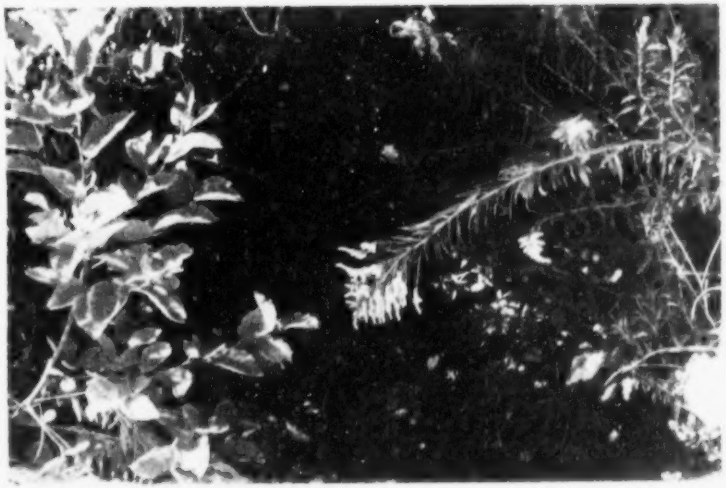
Photograph 14 – Un-named 2+420
Channel at crossing location stable rock

Photograph 15 – Un-named 2+420
Channel at crossing location looking upstream

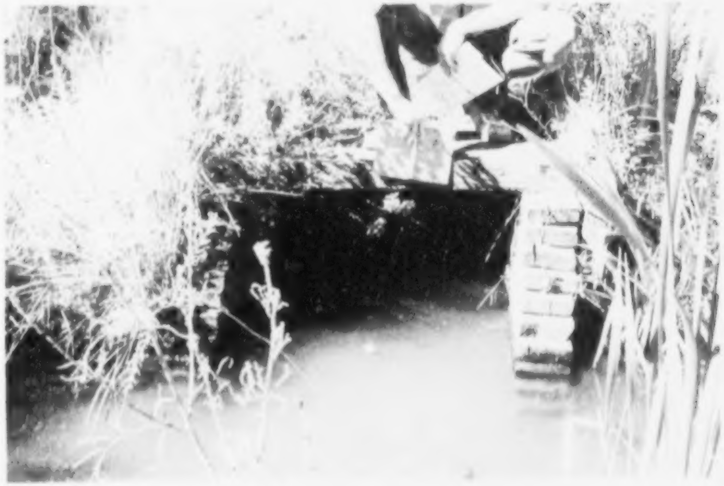
Photograph 16 – Un-named 2+500
At crossing location looking upstream

Photograph 17 – Un-named 2+500
At crossing location looking downstream

Photograph 18 – Un-named 3+910
Channel at crossing location looking upstream



Photograph 19 – Un-named 3+910
Channel at crossing location looking downstream



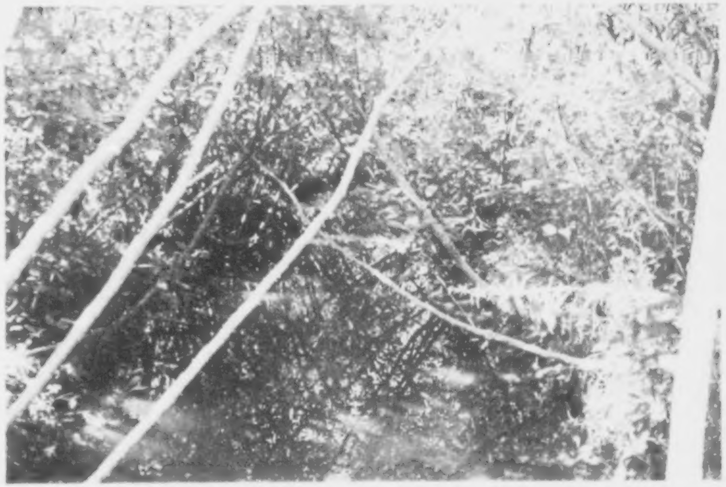
Photograph 20 – Existing structure at highway 104
(downstream of un-named 3+910 and 4+150) u/s side

Photograph 21 – Existing structure at highway 104
(downstream of un-named 3+910 and 4+150) d/s side

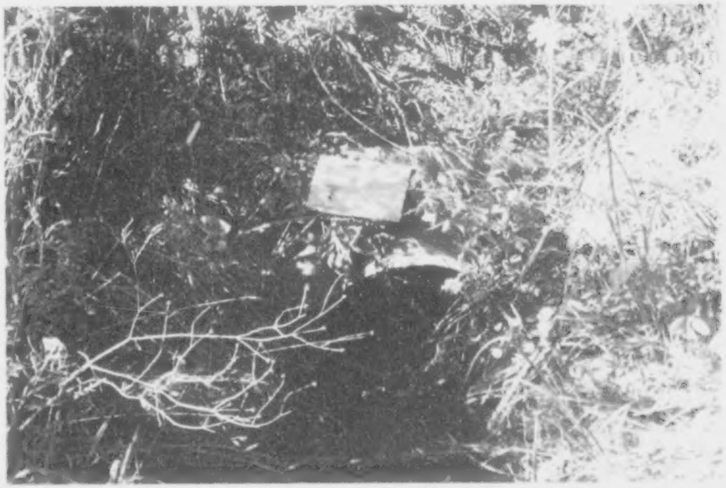
Photograph 22 – Existing structure at highway 104
(downstream of un-named 3+910 and 4+150) storm culvert

Photograph 23 – Un-named 4+150
Existing culvert at crossing upstream side

Photograph 24 – Un-named 4+150
Existing culvert at crossing downstream side



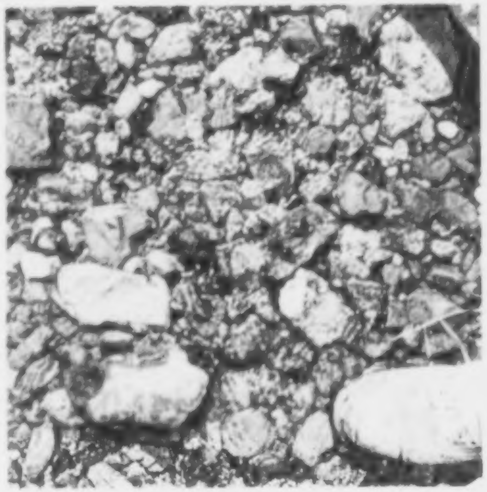
Photograph 25 – Un-named 4+150
Existing culvert at crossing looking downstream



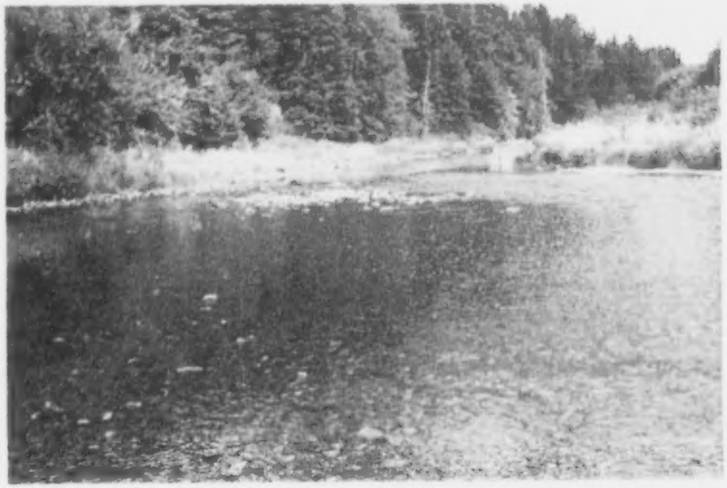
Photograph 26 – Un-named 4+150
Culvert under driveway upstream of crossing location

Photograph 27 – Un-named 5+490
Channel at proposed crossing location

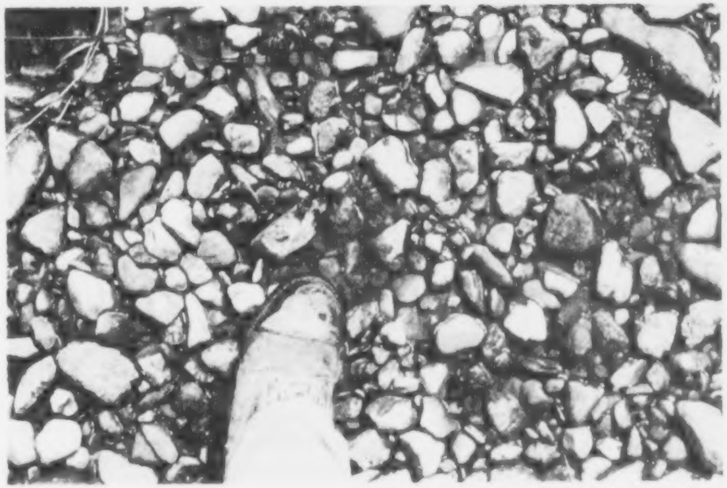
Photograph 28 – West River 5+700
At proposed crossing location looking upstream



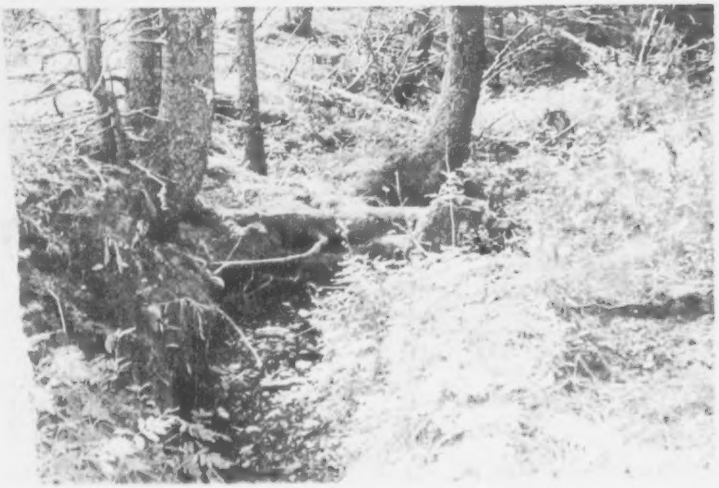
Photograph 29 – West River 5+700
Stable Rock at shallow channel



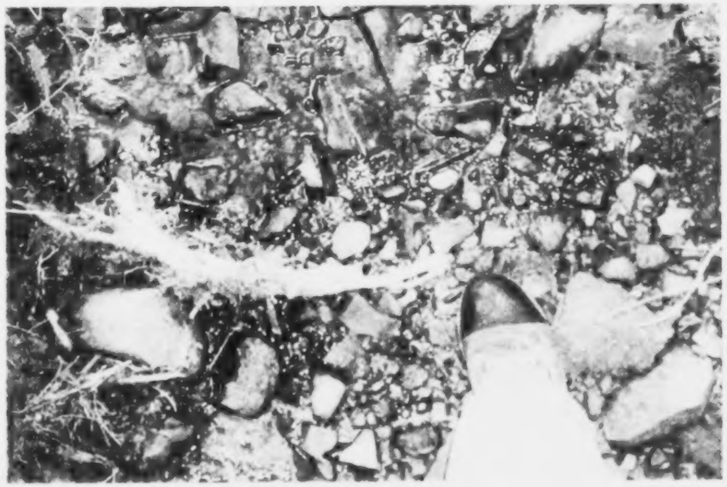
Photograph 30 – West River 5+700
At proposed crossing location looking downstream



Photograph 31 – West River 5+700
Stable Rock at bank



Photograph 32 – Un-named 6+950
At proposed crossing location looking upstream

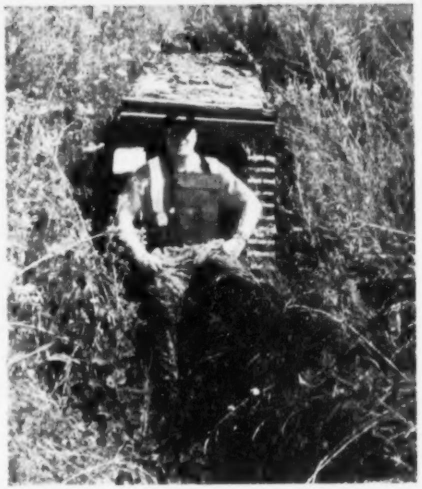


Photograph 33 – Un-named 6+950
At proposed crossing stable rock in channel

Photograph 34 – Un-named 6+950
At proposed crossing location looking downstream

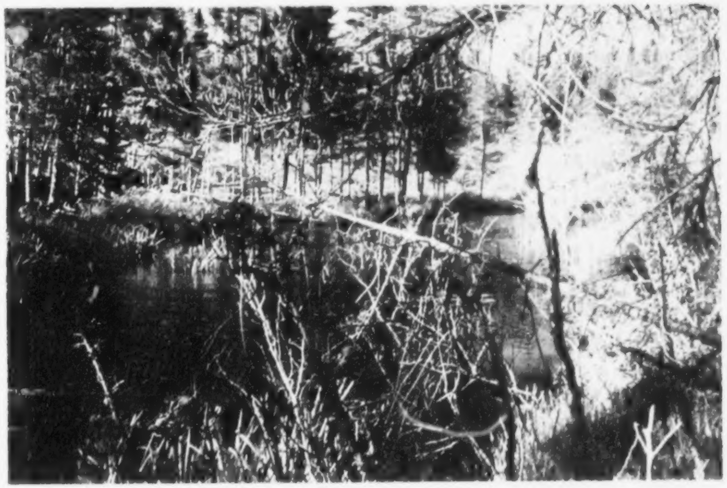
Photograph 35 – Existing Structure at Beech Hill Road
(downstream of un-named 6+950) upstream side

Photograph 36 – Existing Structure at Beech Hill Road
(downstream of un-named 6+950) downstream side

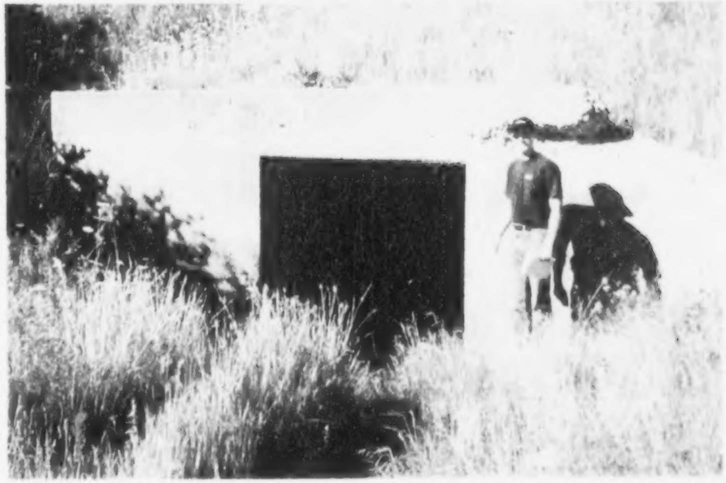


Photograph 37 – Existing Structure under highway 104
(downstream of un-named 6+950) downstream side

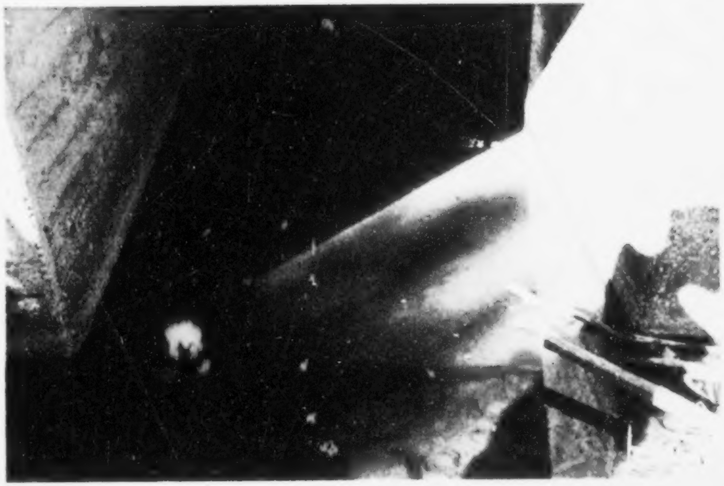
Photograph 38 – Un-named 8+150
At proposed crossing location looking upstream



Photograph 39 – Un-named 8+150
At proposed crossing location looking downstream



Photograph 40 – Existing structure under highway 104
(downstream of un-named 8+150) upstream side

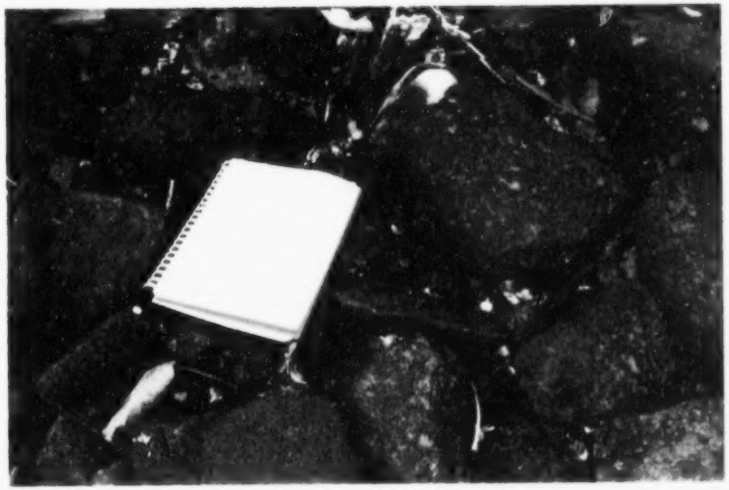


Photograph 41 – Existing structure under highway 104
(downstream of un-named 8+150) upstream side

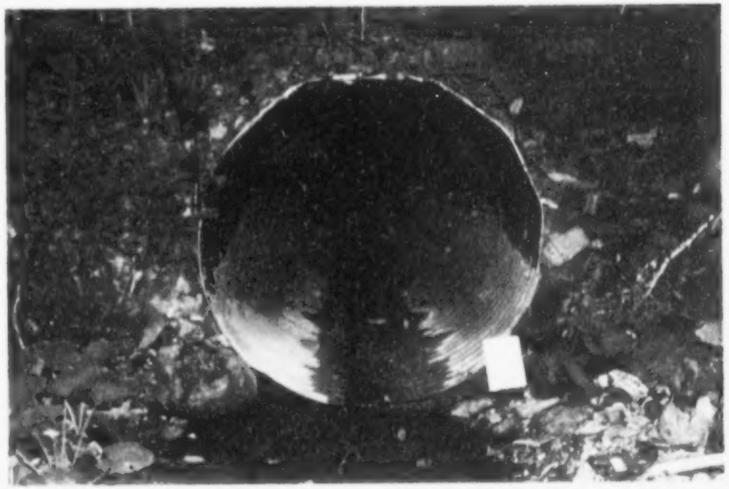
Photograph 42 – Un-named 9+160
At proposed crossing location looking upstream

Photograph 43 – Un-named 9+160
At proposed crossing location looking downstream

Photograph 44 – Un-named 10+250
At proposed crossing location looking upstream

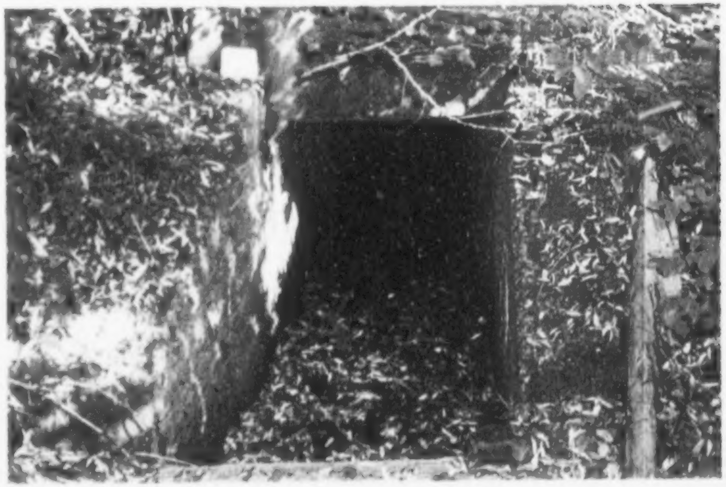


Photograph 45 – Un-named 10+250
At proposed crossing location stable rock

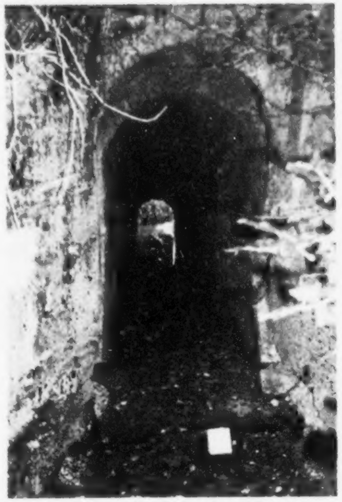


Photograph 46 – Existing structure under highway 104
(downstream of un-named 10+250) downstream side

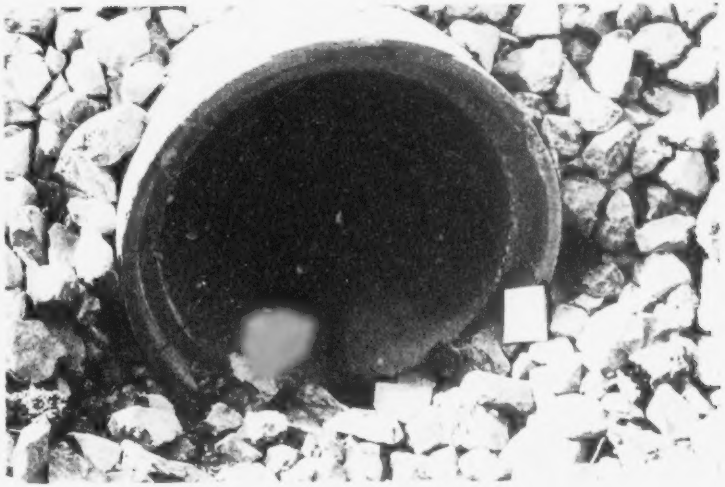
Photograph 47 – Existing structure under highway 104
(downstream of un-named 10+250) upstream channel



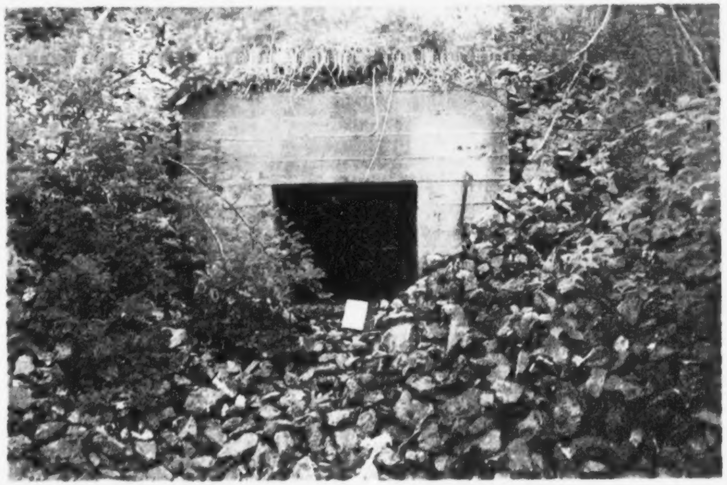
Photograph 48 – Existing structure under highway 104
(downstream of un-named 10+250) upstream side



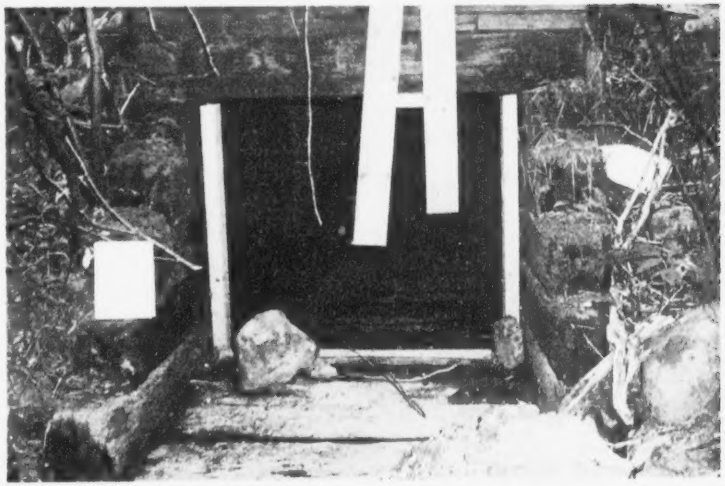
Photograph 49 – Existing structure under secondary road (downstream of un-named 10+250) downstream side



Photograph 50 – Existing structure under highway 104 (downstream of un-named 12+350) upstream side

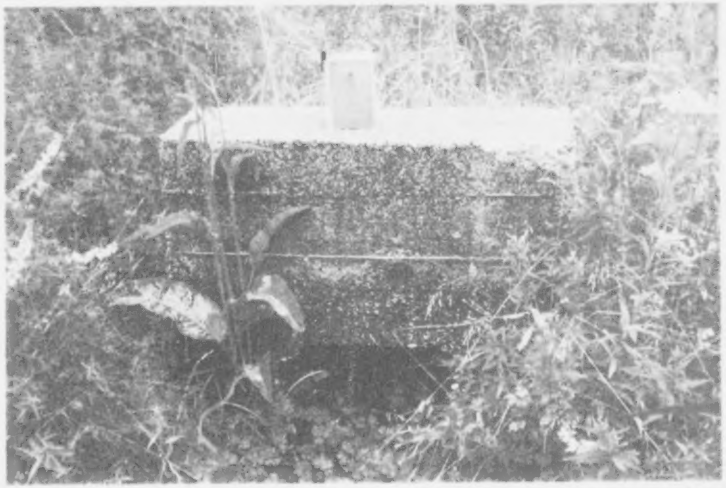


Photograph 51 – Existing structure under secondary road (downstream of un-named 12+350) downstream side



Photograph 52 – Existing structure under secondary road (downstream of un-named 12+350) upstream side

Photograph 53 – Un-named 13+600
Existing structure at proposed crossing, upstream side



Photograph 54 – Un-named 13+600
Existing structure at proposed crossing, downstream side

Photograph 55 – Un-named 13+600
Looking downstream

Photograph 56 – Un-named 14+580
Existing structure at proposed crossing, upstream side

Photograph 57 – Un-named 14+580
Existing structure at proposed crossing, downstream side

APPENDIX C

SUMMARY OF EXISTING ENVIRONMENT

Table C1 Summary of Existing Environment

Constraint	Summary of Existing Conditions	Sources Consulted	Relevant Legislation/Regulation/Guidelines
GEOLOGY			
mineral resources	A few known metallic and industrial mineral occurrences are located within the study area, including gypsum, limestone, lead bog manganese, and clay.	▪ D. Hopper, pers. comm. (1997)	Nova Scotia *Mineral Resources Act*
sand and gravel deposits	Some sand and gravel deposits, which may still be producing, are located in the western portion of the study area and are anticipated to increase in importance with the realignment project. In addition, these types are possible hosts for aquifers.	▪ D. Hopper, pers. comm. (1997)	Pit and Quarry Guidelines (NSDOE 1999)
mineralized slates	There are no known occurrences of acid producing slates in the area. The geology and mineralization in the study area do not produce acid generating conditions such as in areas underlain by Meguma rocks.	▪ D. Hopper, pers. comm. (1997) ▪ Review of geological mapping for Antigonish	*Nova Scotia Sulphide Bearing Material Disposal Regulations* *Fisheries Act* *Canadian Environmental Protection Act* Guidelines for Development on Slates in Nova Scotia (NSDOE and Environment Canada 1991)
shallow bedrock	The majority of the study area is blanketed by compact till, chiefly composed of silt and some clay. Clay till and glaciofluvial sand and gravel deposits underlie the study area. Bedrock outcrops were not noted during the walkover but some exposure is likely at watercourse crossings where the overburden has been eroded.	▪ D. Hopper, pers. comm. (1997) ▪ JWEL Field survey (2002)	N/A
karst terrain	There is potential for karst development in about 40% of the study area. Area underlain by Windsor Group rocks with near surface gypsum and anhydrite is regarded to have the highest potential for karst development. This occurs in areas underlain by the Gays River and Bridgeville Formations in the north central part of the study area and bounded by the Antigonish Thrust fault. Areas with moderate potential include the Windsor Group rocks that include the Hastings, Hood Island and Addington Formations. These rocks consist of thin interbeds of gypsum and limited but possible karst development. Areas with low potential for karst development include the Mabou Group (formerly Canso Group) rocks. No evidence of Karst development was noted during a walkover of the proposed alignment or during a borehole investigation conducted at the proposed South River crossing.	▪ D. Hopper, pers. comm. (1997) ▪ JWEL Field survey (2002) ▪ Neill and Gunter Ltd. (2001)	N/A
topography	The alignment follows within 600 m of the current 104 alignment at elevations ranging from sea level at Lower South River, to just over 50 m above sea level, and generally drains northwards through streams and watercourses into Antigonish Harbour.	▪ 1:20000 NTS	N/A
highly erodible soils	The surface units underlying this area are not known to exhibit any natural constraints attributed to erosion, however there are sandy and silty tills present in the study area which may be susceptible to erosion. The glacial tills are relatively fine grained and are sensitive to moisture. Both tills and glacial fluvial materials are erodible.	▪ D. Hopper, pers. comm. (1997) ▪ C. MacInnis, pers. comm. (1997) ▪ JWEL Field survey (2002)	*Fisheries Act*

Table C1 Summary of Existing Environment

Constraint	Summary of Existing Conditions	Sources Consulted	Relevant Legislation/Regulation/Guidelines
	TERRESTRIAL ENVIRONMENT		
wildlife management areas	Two wildlife management areas are found in the general vicinity of the proposed highway including the Dagger Woods marsh and the Antigonish Harbour Wildlife Management Areas. The proposed RoW is not located in close proximity to either of these sites.	▪ R. Gautreau, pers. comm. (1997) ▪ M. Pulsifer, pers. comm. (1997)	N/A
ecological reserves	None present in study area.	▪ D. MacKinnon, pers. comm. (1997)	N/A
rare and endangered species	Fourteen rare or uncommon vascular plants have been previously recorded in the general vicinity of the study area including *Cuscuta cephalantha, Cystopteris bulbifera, Carex eburnea, Bidens hyperborea, Erigeron hyssopifolius, Eupatorium rugosum, Floerka proserpinacoides, Lilium canadensis, Platanthera grandiflora, Potamogeton obtusifolius, Potamogeton praelongus, Samolus floribundus, Triosteum aurantiacum,* and *Zizea aurea.* Three of these species (*Lilium canadensis, Plantanthera grandiflora and Triosteum aurantiacum*) were found along the proposed highway RoW during the field surveys. An additional nine uncommon species were encountered during the field survey including *Asclepias incarnata, Fraxinus nigra, Ceratophyllum demersum, Laportea canadensis, Sanguinaria canadensis, Lysimachia thyrsiflora, Polygonum pensylvanicum, Proserpinaca palustris* var. *creba*, and *Potamogeton richardsonii.* Eighteen rare or uncommon bird species have been recorded in the general vicinity of the study area including Piping Plover, Whip-poor-will, Wood Thrush, Warbling Vireo, Philadelphia Vireo, Red-breasted Merganser, Eastern Phoebe, Vesper Sparrow, Nelson's Sharp-tailed Sparrow, Northern Goshawk, Common Tern, Arctic Tern, Bobolink, Northern Oriole, Merlin, Black-backed Woodpecker, Boreal Chickadee, and Rusty Blackbird. Three of these species, Nelson's Sharp-tailed Sparrow, Bobolink and Boreal Chickadee were found in or near the proposed RoW. Another uncommon species, Black-billed Cuckoo, which was not previously recorded in the general area was encountered along the RoW. Two raptor species, Bald Eagle and Osprey are known to nest near the RoW. One sensitive reptile species, wood turtle has been reported from the vicinity of the proposed RoW but was not encountered during the field surveys. The only rare or uncommon invertebrate recorded from the area is the Pearl Mussel *Margaritifera margaritifera* (L.).	▪ R. Ogilvie, pers. comm. (1997) ▪ M. Pulsifer, pers. comm. (1997 and 2002) ▪ A. Hebda, pers. comm. (2002) ▪ Fuller (1998) (unpublished) ▪ Pronych and Wilson (1993) ▪ JWEL Field surveys (2002) ▪ ACCDC (2002) ▪ COSEWIC (2002)	Nova Scotia *Endangered Species Act* *Species at Risk Act* Nova Scotia *Wildlife Act* *Migratory Birds Convention Act*
managed wetlands	The Dagger Woods Marsh is a managed wetland identified as a constraint. This is a significant Ducks Unlimited project managed jointly with DNR. The area includes the wetland itself and the surrounding Crown Land as well. Water levels are managed on 90 acres of marsh and 124 acres of adjacent uplands are included. This area is not within the study area defined following the selection of the proposed alignment.	▪ J. Wile, pers. comm. (1997) ▪ JWEL Field survey (2002) ▪ Beardmore (1985)	N/A

Table C1 Summary of Existing Environment

Constraint	Summary of Existing Conditions	Sources Consulted	Relevant Legislation/Regulation/Guidelines
important habitat	Noted important habitat in the study area includes Osprey and Bald Eagle nest sites as well as foraging sites for these species in the South River estuary. The watercourses within the study area are important habitat for salmonids, eel and gaspereau. The South River supports a breeding population of Striped Bass, a species of concern due to declining numbers in the region, and is an exceptional watercourse because of the diversity of species it supports. The Atlantic Salmon is a significant species on the West River. The South River estuary area between the existing Highway 104 and the trestle at the entrance to the Antigonish Harbour was identified as a particularly biologically productive area. There are two sensitive habitat types found along the route including rich intervale habitat at the West River crossing site and coastal freshwater marsh at the South River crossing site. The South River site provides habitat for a variety of sensitive birds	▪ R. Ogilvie, pers. comm. (1997) ▪ M. Pulsifer, pers. comm. (1997 and 2002) ▪ JWEL Field surveys (2002) ▪ Neill and Gunter Ltd. (2001)	Nova Scotia *Wildlife Act* *Migratory Birds Convention Act*
important wetlands	The Dagger Woods Marsh and the South River Estuary have wetlands with Golet Scores exceeding 60. The Brierly Brook wetland has also been identified as a valuable wetland. During the field surveys four wetlands were identified as having moderate value due to their ability to regulate stream flow. The Dagger Woods Marsh is outside the study area.	▪ D. MacKinnon (1999) ▪ R. Gautreau pers. comm. (1997) ▪ M. Pulsifer, pers. comm. (1997) ▪ JWEL Field surveys (2002)	*Migratory Birds Convention Act* *Nova Scotia Wildlife Act* NSDOE *Wetlands Directive*
protected beaches	None present in the study area.	▪ NSTPW (2001a) ▪ Field reconnaissance ▪ Aerial photographs	N/A
old growth forest	One site adjacent to West River approximately 2km south of Highway 104 and outside of the proposed RoW was identified by NSDNR. Old growth forest was not observed during field surveys.	▪ D. MacKinnon, pers. comm. (1997) ▪ JWEL Field surveys (2002)	N/A
trees of distinction	None present in the study area.	▪ Field reconnaissance	N/A
AQUATIC ENVIRONMENT			
rivers/lakes	A review of aerial photography and mapping indicated 30 potential watercourses in the study area. Of these, sixteen watercourses were identified in the field. The proposed alignment crosses the West and South Rivers.	▪ JWEL Field survey (2002) ▪ 1:20,000 NTS ▪ 1:10,000 aerial photographs	*Fisheries Act* *Navigable Waters Protection Act* Nova Scotia *Environment Act*
significant fish habitat	DFO has identified the following significant fish habitat in and around the study area: ▪ The study area contains five major salmon streams and ten trout streams. Fisheries supported in this area include Native food fisheries, gaspereau, rainbow trout, brook trout, striped bass, smelts and eels. ▪ Brierly Brook has been the subject of a five year pilot project in restoration of spawning areas and rearing habitat for Atlantic Salmon and Brook Trout.	▪ C. MacInnis, pers. comm. (1997) ▪ JWEL Field survey (2002) ▪ Neill and Gunter Ltd. (2001)	*Fisheries Act*

Table C1 Summary of Existing Environment

Constraint	Summary of Existing Conditions	Sources Consulted	Relevant Legislation/Regulation/Guidelines
	▪ The West River and Brierly Brook systems have the highest juvenile salmon densities per unit area of any watershed in the Maritimes with salmon spawning being evenly distributed throughout the study area. ▪ The West River has also been the recipient of restoration work over the last eight years. ▪ South River supports a very diverse fishery for Atlantic Salmon, sea trout, brown trout, rainbow trout, striped bass, gaspereau and others. Section 5.3.2 presents electrofishing results and reported species in the stream crossings of the RoW.		
flood plain	The Flood Risk Map (1984) for the region shows that the alignment along the West River is designated as a 1:20 year floodway. The limits of floodway are approximately 150 m on the east side of the river and less than 50 m on the west bank. The alignment is at the southern limit of flood mapping. There are flood plains associated with the South River as well.	▪ Antigonish Area Flood Risk Map (1984) ▪ JWEL Field survey (2002) ▪ Neill and Gunter Ltd. (2001) ▪ Aerial photographs	*Municipal Government Act* - Statement of Provincial Interest Regarding Flood Risk Areas.
MARINE ENVIRONMENT			
marine habitat	None present in study area.	▪ JWEL Field survey (2002) ▪ Aerial photographs	N/A
salt marsh	The South River estuary north of the existing 104 is classified as a productive salt marsh.	▪ C. MacInnis, pers. comm. (1997) ▪ Neill and Gunter Ltd. (2001)	N/A
CROWN LANDS			
provincial parks	None present in study area.	▪ J. Armstrong (1997) ▪ 1:10 000 mapping	N/A
national parks	None present in study area.	▪ 1:50 000 NTS mapping	N/A
federal lands	No federal lands present in undeveloped areas of the study area.	▪ G. Reid, pers. comm. (1997)	N/A
park reserves	None present in study area.	▪ J. Armstrong (1997) ▪ D. MacKinnon (1997)	N/A
NATIVE LANDS			
Indian reserves	None present in study area	▪ 1:50 000 NTS mapping	N/A
Native land claims	None present in study area.	▪ J. Powell, pers. comm. (1997)	N/A
AGRICULTURE			
active agriculture	There are agricultural operations throughout the study area.	▪ Aerial photography ▪ JWEL Field survey (2002) ▪ 1:10 000 mapping	N/A
fur farms	There is one fox fur farm in the study area located north of the existing 104 in Lower West River.	▪ M. Johnson, pers. comm. (1996) ▪ 1:10 000 mapping	N/A
agricultural capability	The majority of soil within the study area has good agricultural capability for crop land.	▪ Hilchey and Cann (1954)	N/A

Table C1 Summary of Existing Environment

Constraint	Summary of Existing Conditions	Sources Consulted	Relevant Legislation/Regulation/Guidelines
FORESTRY			
intensive forestry management	None present in study area.	▪ B. White, pers. comm. (1997) ▪ 1:10 000 mapping	Nova Scotia *Wildlife Habitat* and *Watercourse Protection Regulations* Nova Scotia *Forests Act*
woodlot management	The are a number of actively managed private woodlots in the study area. There is a Stora Port Hawkesbury managed woodlot on Crown Land approximately one and half km south of the alignment east of Salt Springs.	▪ C. Simpson, pers. comm. (1997) ▪ JWEL Field survey (2002)	Nova Scotia *Wildlife Habitat* and *Watercourse Protection Regulations* Nova Scotia *Forests Act*
sugar bush	None present in the study area.	▪ C. Simpson, pers. comm. (1997)	N/A
LAND/WATER USE			
urban/rural development	The majority of the RoW crosses wooded land with some hay production or pasturage as well. Urban development is concentrated in the Antigonish area along the existing Highway 104 and in the Town. Many residences within the study area are concentrated along the existing Highway 104 and adjacent roads, such as Trunk 7, the Beech Hill Road and Route 316. There are some areas of residential development in proximity to the proposed alignment, particularly at Addington Forks Road, the mobile home park near the Oasis Motel, Dunn's Loop and Taylor Road.	▪ NSTPW (2001a) ▪ JWEL Stakeholder consultations (2002)	N/A
proposed development	The Municipal Planning Strategy for the study area shows the alignment area west of Taylor Road unplanned as far west as West River. The intersection of the planning area and the alignment begins around Route 7. The areas immediately adjacent to Route 7 are zoned as residential and commercial. The area of the alignment approximately 1 km north of Sommers Road, south of the existing Highway 104, east and north of the power line and approximately 2.5km west of Route 7 is zoned highway commercial. Proposed development included a development plan for a residential subdivision was recently submitted for a parcel of land (station 3+600) which will be severed by the alignment. A cemetery south of the existing highway had planned to expand further south. The owner is now planning an expansion to the east to accommodate the alignment.	▪ S. Day, pers. comm. (1997) ▪ Town of Antigonish Municipal planning Strategy ▪ JWEL Stakeholder consultations (2002)	
airports and navigational aids	None present in study area.	▪ R. Lynch, pers. comm. (1994) ▪ Field reconnaissance	N/A
landfills/waste disposal sites	The Beech Hill landfill is located south of the study area (NTS 1:50000 grid reference 805465).	▪ 1:50 000 NTS mapping ▪ D. Shea, pers. comm. (1997)	N/A
strip mines	None present in study area.	▪ D. Hopper, pers. comm. (1997) ▪ Field reconnaissance	N/A
surface facilities of active underground mines	None present in study area.	▪ D. Hopper, pers. comm. (1997)	N/A
underground mines	None present in study area.	▪ D. Hopper, pers. comm. (1997)	N/A

Table C1 Summary of Existing Environment

Constraint	Summary of Existing Conditions	Sources Consulted	Relevant Legislation/Regulation/Guidelines
pits and quarries	None present in study area.	▪ D. Hopper, pers. comm. (1997) ▪ 1:50 000 NTS mapping	Nova Scotia *Environment Act* Nova Scotia Pit and Quarry Guidelines (NSDOE 1999)
advanced mineral exploration claims	Mineral claims have been staked for kaolin clay and limestone	▪ D. Hopper, pers. comm. (1997)	N/A
petroleum exploration	Seismic programs conducted in Antigonish area in 2001 or 2002. Exploration well (Beech Hill #1) drilled in 2003 (abandoned).	▪ P. Harvey, pers. comm. (2004)	Nova Scotia *Environment Act* Nova Scotia *Petroleum Resources Act*
navigable waters	West River and South River are Navigable Waters.	▪ 1:50 000 NTS mapping ▪ Aerial photographs ▪ NSTPW (2001a)	N/A
aquaculture	None present in study area.	▪ Sweeney, C. R. pers. comm. (1996) ▪ Nova Scotia Department of Agriculture and Fisheries (2002)	N/A
recognized views	None present in study area.	▪ NSTPW (2001a)	N/A
RECREATION			
canoe route	None present in study area.	▪ Trails Nova Scotia (2002)	N/A
cross country ski trails	None present in study area.	▪ Trails Nova Scotia (2002)	N/A
hiking trails	None present in study area.	▪ J. Armstrong pres. comm. (1997) ▪ Trails Nova Scotia (2002)	N/A
miscellaneous recreation	There are recreational facilities at the following locations within the study area: The Oland Centre, skating rink and auditorium at St. Francis Xavier University; the Antigonish Arena; the Antigonish Fire Hall; the Community Centre/Daycare; the Lower South River Ballfield. Snowmobile trails are located north of the existing Highway 104 by the Shopping Centre and vary from year to year. Recreational fishing occurs on the West and South Rivers.	▪ K. Proctor, pers. comm. (1997) ▪ S. Day, pers. comm. (1997) ▪ C. MacInnis, pers. comm. (1997 ▪ M. Pulsifer, pers comm. (1997)	N/A
WATER SUPPLY			
surface water supply	None present in study area other than a small, non-potable, surface water reservoir in use at MacEachern Collision Centre.	▪ NSTPW (2001a) ▪ JWEL Field survey (2002)	Nova Scotia *Environment Act* Nova Scotia *Health Act* *Guidelines for Canadian Drinking Water Quality*
groundwater supply	Groundwater is used for individual well water supplies in the area and there is a municipal water supply wellfield with six production wells in the Lower South River area. The proposed alignment passes through the outermost protection zone of the wellfield.	▪ D. Shea, pers. comm. (1997) ▪ B. Farrell, pers. comm. (1997) ▪ NSDOE Well Driller Logs ▪ JWEL Field survey (2002)	Nova Scotia *Environment Act* Nova Scotia *Health Act* *Guidelines for Canadian Drinking Water Quality*
developed springs	None present in study area.	▪ NSTPW (2001a)	N/A
UTILITIES			
power transmission lines	There are multiple NSPI power transmission (69 kV and over) and distribution (69 kV) lines in the study area. NSPI lines will cross the proposed RoW north east of Addington Forks Road, just west of Kell Road and south west of MacEachern Loop.	▪ NSTPW (2001a) ▪ 1:50 000 NTS mapping	N/A

Table C1 Summary of Existing Environment

Constraint	Summary of Existing Conditions	Sources Consulted	Relevant Legislation/Regulation/Guidelines
municipal services	Water lines follow the current South Side Harbour Road north of Highway 104 up to the approximate location of the railroad crossing. Water lines are in place along the Highway 4 approximately 1.5 km north of Highway 104 extending for about 1 km. There is a short section of water lines that are installed along the Lower West River Road from where it joins Trunk 7 to west to the small road extending north where it turns north toward the power line and joins the water and sewer line. There is an approximate 1.5km section of water line that extends south at the junction of Addington Forks Road and Route 104. Water and sewer lines are present adjacent to the 104 from approximately 1 km east of Route 316 to the Dunmore Road. These lines are also installed along Highway 4 from the 104 heading northwest into Antigonish and extending less than 1km north on Williams Point Road, south on Beech Hill Road and north and south on Timothy Lane. There are also lines on Cunningham Road south to approximately where the power transmission lines intersect the road. Water and sewer lines are in place on either side of Trunk 7 from the mobile home park up to and along Highway 104, west to Sommers Road where they extend less than 1km. There is a sewer line that extends from the end of the water and sewer line on Sommers Road, loops west back down to approximately MacIsaac Road, back north just west of North Street and ends south of the mobile home park where a very short segment of water and sewer line tees off to the east.	▪ K. Proctor, pers. comm. (1997) ▪ G. Ho, pers. comm. (1997)	N/A
telecommunications towers	There is one tower in the study area.	▪ J. Thiessen, pers. comm. (1997)	N/A
telephone lines/fibre optic cable	The RoW will intersect telephone lines in numerous places; aerial cable lines every road crossing the alignment. Aerial fibre optics extend from Antigonish Centre to Route 4, south to Highway 104 where the lines continue along the highway to Heatherton. Aerial fibre optics and cable are also in place along the Beech Hill Road as far south as Beech Hill where the power line intersects the road. Just north of the alignment, west of Beech Hill Road, aerial fibre optics follow the power line to join up on Cunningham road where the lines continue up to the Highway (104) and extend north of the 104 on Church Street past the shopping centre. Buried fibre optics follow the power transmission lines from Salt Springs Brook northeast to Lower South River where the lines continue east to Heatherton. Buried cable is found in a few places within the study area. A very short segment is buried at the end of Willowdale Lane south of the silo and another similar size segment crosses Highway 104 immediately west of the Beech Hill Road between the highway and the power line to the south. Other buried cable is found at various locations off Trunk 7. A short (<0.5km) segment is buried east of Trunk 7 less than 1km south of the West River bridge. A larger section of buried cable begins approximately 0.5km down the Cameron Kinney Hill Road, continues up to Trunk 7 and goes south past Salt Springs Brook and follows the next road to the south down to the transmission lines.	▪ L. MacKinnon, pers. comm. (1997) ▪ 1:50 000 NTS mapping	N/A
cable television lines	It is unknown if there is buried cable in the study area.	▪ NSTPW (2001a)	N/A

Table C1 Summary of Existing Environment

Constraint	Summary of Existing Conditions	Sources Consulted	Relevant Legislation/Regulation/Guidelines
miscellaneous pipelines/cables	There are no pipelines/cables in the study area.	▪ NSTPW (2001a)	N/A
active railway lines	The active railway lines within the study area around South River station but do not intersect the alignment.	▪ NTS 1:50 000 mapping ▪ JWEL Field survey (2002)	N/A
ARCHAEOLOGY/HERITAGE			
national historic sites	None present in study area.	▪ R. Thompson, pers. comm. (1997)	N/A
heritage properties	There are no registered heritage sites along the alignment. The registered heritage properties in proximity to the project are along Church Street north of Highway 104. Three heritage features were identified during JWEL field investigations; namely a rock mound (3+900), a rock wall (4+100) and a dilapidated house (10+540). The house was of moderate significance while the rock pile and the rock wall were low. A bridge footing believed to be from an 1853 crossing of the South River was found during the South River Impact Study investigation. The footing is of low significance.	▪ G. Ho, pers. comm. (1997) ▪ K. Proctor, pers. comm. (1997) ▪ W. Brown, pers. comm. (1996) ▪ JWEL Field survey (2002) ▪ Neill and Gunter Ltd. (2001)	N/A
archaeological sites	The Nova Scotia Museum has no records of reported archaeological sites or of rare or significant fossils within the study area. No archaeological sites were encountered during field investigations.	▪ R. Ogilvie, pers. comm. (1997) ▪ JWEL Field survey (2002) ▪ Neill and Gunter Ltd. (2001)	Nova Scotia *Heritage Property Act* Nova Scotia *Special Places Protection Act*
old burial grounds/cemeteries	There is an old cemetery located just north of the alignment in the vicinity of station 10+900 and another located just north of the alignment around station 4+700. Neither of the cemeteries is within the study area.	▪ 1:50 000 NTS mapping ▪ NSTPW. (2001a) ▪ JWEL Field survey (2002) ▪ Neill and Gunter Ltd. (2001)	Nova Scotia *Cemeteries Protection Act*
heritage rivers	None present in study area.	▪ J. Armstrong pres. comm. (1997) ▪ NSDEL 2002c	N/A
AIR QUALITY			
air quality	No heavy industry present. Generally good air quality due to maritime climate and small population base. Occasional long-range transport of air masses from central Canada or the Eastern seaboard may cause poorer air quality from transported contaminants.	▪ NSDOE (1998)	*Canadian Environmental Protection Act - Ambient Air Quality Objectives* Nova Scotia *Air Quality Regulations*
NOISE			
ambient noise	The values recorded at all baseline locations demonstrate typical levels expected in rural communities and outlying homes. The main sources of noise noted during the survey were traffic along the existing Highway 104 or local roadways, and normal residential outdoor activity.	▪ JWEL Field survey and baseline sampling (2002)	NSDOE *Guidelines for Environmental Noise Measurement and Assessment* (1989)
PUBLIC INTEREST			
public interest	Three public consultation open houses were held in Antigonish, in 1997, 1998 and 2001. Although there was general consensus regarding the need for the project, there is mixed public reaction on the proposed design and alignment as well as compensation issues.	▪ NSTPW (2001a)	N/A

Table C1 Summary of Existing Environment

Constraint	Summary of Existing Conditions	Sources Consulted	Relevant Legislation/Regulation/Guidelines
WEATHER/CLIMATE			
weather/climate	Mean temperatures range from 18.2 C in July to –6.6 C in January and February. Approximately 35 days with measurable snowfall per year (*i.e.*,=>0.2 cm), totalling 208 cm; approximately 108 days with measurable rainfall per year (*i.e.*,=>0.2 mm), totalling 1175.7 mm (Collegeville, NS).	▪ Environment Canada (2002)	N/A
TRANSPORTATION NETWORK			
transportation network	The proposed Highway 104 alignment is located in Antigonish County, in the Northern portion of the province, stretching approximately 15 km from Addington Forks to Taylor Road. Current traffic volumes range from 1000 to 15000 vehicles per day (vpd) in the study area. The upgrading if this stretch will see the continuation of the 100 series four-lane, divided controlled access highway from Amherst through to Antigonish. Presently motorists using the existing Highway 104 are a mix of local and through traffic. Some of the routes carrying traffic to the existing highway include Trunk 4, Trunk 7, Beech Hill Road and Route 316.	▪ NSTPW (2001a)	N/A

Personal Communications Undertaken by NSTPW for Highway Environmental Database Screening and included in Table C1:

Armstrong, J.V. Planning Technician, Parks and Recreation Division, Nova Scotia Department of Natural Resources, March 19, 1997
Brown, W. Head of Heritage, Municipal Services Division, Nova Scotia Department of Housing and Municipal Affairs, Halifax, NS December 20, 1996
Day, S. Town Planner, Town of Antigonish, Antigonish, NS January 10, 1997
Dupuis, M. Manager of Commercial Development, Airports Division, Transport Canada, Moncton, NB, December 4, 1996
Farrell, B. Municipality of the Town of Antigonish, Antigonish, NS April 4, 1997
Fraser, G. Crown Land Forester, Nova Scotia Department of Natural Resources, Amherst Nova Scotia January 29, 1997
Gautreau, R. Canadian Wildlife Service, Atlantic Region, Sackville, New Brunswick February 12, 1997
Ho, G. Planner, Municipality of the County of Antigonish, Antigonish, NS January 10, 1997
Hopper, D.B. Land Use Planner, Department of Natural Resources, Halifax, Nova Scotia, March 18, 1997
Hubley, M. Regional Superintendent, Navigable Waters Protection, Maritime Region, Canadian Caost Guard, Department of Fisheries and Oceans Canada, Dartmouth, NS November 22, 1996
Johnson, M. Fur Farm Technician, Animal Industry Branch, Nova Scotia Department of Agriculture and Marketing, Truro, NS December 2, 1996
MacInnes C. Area Habitat Coordinator Gulf Region, Department of Fisheries and Oceans, Nova Scotia February 07, 1997
MacKinnon, D. Ecological Planner, Protected Areas Division, Nova Scotia Department of Environment, Belmont, NS Febraury 27, 1997
MacKinnon, L. Maritime Tel&Tel, New Glasgow, NS January 8, 1997
Ogilvie, R. Curator, Special Places, Nova Scotia Museum, Halifax, N.S., February 21, 1997
Powell, J., Lands Officer, Indian and Northern Affairs Canada, Atlantic Region, Amherst, Nova Scotia, February 28, 1997
Proctor, K. Town Engineer, Town of Antigonish, Antigonish NS, January 10, 1997
Pulsifer, M. Regional Biologist, Nova Scotia Department of Natural Resources, Antigonish, NS, February 26, 1997
Reid, G., Land Surveys and Inventories, Public Works Canada, Halifax, NS March 10, 1997
Shea, D. Public Health Engineer, Nova Scotia Department of the Environment, Antigonish, NS December 16, 1996
Sweeney, C.R. Aquaculture Development Officer, Nova Scotia Department of Fisaheries, Halifax, NS December 3, 1996
Theakston, J. Environmental Engineer, Ecosystem and Risk Management Branch, Nova Scotia Department of Environment, Halifax, NS, December 2, 1996
Thiessen, J. Manger, Spectrum, Industry Canada, Dartmouth NS, February 27, 1997
Thompson, R. Head, Historic Sites Planning, Parks Canada, Halifax, N.S. March 12, 1997
White, B. Manager Reforestation, Forestry Division, Nova Scotia Department of Lands and Forests. Truro, NS January 5, 1997
Wile, J. Area Biologist. Ducks Unlimited Canada. Amherst, NS November 28, 1996

Note: Refer to Section 13 of the Environmental Assessment Report for remainder of references.

APPENDIX D

AQUATIC FIELD SURVEY RESULTS

- Fish Habitat and Fish Habitat Survey Results
- Water Quality Analysis Results

Table D1 **Fish Species Which Were Found or May Occur in the Brooks Within the RoW of the proposed Highway 104 - Antigonish**

Common Name	Scientific Name	Observed (O) Likely to Occur (L)
American eel	*Anguilla rostrata*	L
Atlantic salmon	*Salmo salar*	O
Brown trout (sea run)	*Salmo trutta*	L
Brook trout (sea run)	*Salvelinus fontinalis*	L
Creek chub	*Semotilus atromaculatus*	O
Gaspereau (alewife)	*Alosa pseudoharengus*	L
Nine-spine stickleback	*Pungitius pungitius*	O
American shad	*Alosa sapidissima*	L
Rainbow smelt	*Osmerus mordax*	L
Northern redbelly dace	*Phoxinus eos*	O
Banded killifish	*Fundulus diaphanus*	O
Three-spine stickleback	*Gasterosterous sculeatus*	O
Four-spine stickleback	*Apeltes Quadracus*	O

Table D2 **Benthic Invertebrate Species Which Were Found or May Occur in the Brooks Within the RoW of the proposed Highway 104 - Antigonish**

Order	Family	Found at Crossing #	Tolerance Value[1]
Diptera	Simulidae	5 – upstream	6
Diptera	Tipulidae	5 – upstream	3
Diptera	Other	5 – upstream	
Diptera	Tipulidae	5- downstream	3
Diptera	Other	5- downstream	
Coleoptera	Psephenidae	5-downstream	4
Ephemeroptera	Ephemerillidae	5-downstream	1
Diptera	Simulidae	8 - upstream	6
Diptera	Chironomidae	8 – upstream	6-8
Diptera	Other	8 – upstream	
Ephemeroptera	Ephemerillidae	8 – upstream	1
Trichoptera	Odontoceridae	8 – upstream	0
Trichoptera	Limnephilidae	8 – upstream	4
Plecoptera	Perlidae	8 - upstream	1
Coleoptera	Psephenidae	8 - downstream	4
Diptera	Chironomidae	8 - downstream	6-8
Ephemeroptera	Ephemerillidae	8 - downstream	1
Trichoptera	Odontoceridae	8 - downstream	0
Diptera	Other	8 - downstream	

[1] Mandaville S.M. 2002. Benthic Macroinvertebrates in freshwater- Tolerance Family Level.
Tolerance value range from 0 for organisms very intolerant of organic wastes to 10 for organisms very tolerant to organic wastes.

Fish Habitat Survey Parameters

physical units:	riffles, pools, runs, glides/flats, falls, cascades, chute, rapids
stream morphology:	main channel, braided, spilt channel, etc.
substrate composition:	detritus, composed of small organic particles silt/clay, <0.08 mm sand 0.08 - 4.75 mm gravel 4.75 - 75 mm cobble 75-300 mm boulder >300 mm bedrock
embeddedness:	0-20%, 20-35%, 35-50%, >50%
stream depth:	average of **?**, **?** and **?** across channel
widths:	wet and channel width
bank height:	height of bank at waters edge
water velocity:	measured time for floating object to travel one metre
bank stability:	75-100% stable, little or no erosion, no slumping, growth of vegetation 50-75% moderately stable, eroding at moderate pace, 2:1 angle, vegetation on slope 0-50% highly unstable, 1:1 angle, loose material rolling down, trees toppled
instream cover:	undercut banks, ricks, logs, trees, pools, debris none 0%, sparse 0-25%, moderate 25-75%, dense 75-100%
overhead cover:	0-20%, 20-50%, 50-75% >75%
bank cover:	percentage cover and species
dissolved oxygen (DO):	calibrated DO meter
temperature:	calibrated dissolved oxygen meter
pH:	calibrated pH meter
conductivity:	calibrated conductivity meter

Rearing and Spawning Habitat Classification System

Rearing and spawning habitat was classified using a rating system. The categories within this system are as follows:

Table D3	**Rearing and Spawning Habitat Classification System**
Type 1	Good salmonid spawning and rearing habitat
flows:	moderate riffles, current 0.1 to 0.3 m/s
depth:	relatively shallow, 0.3 to 1.0 m
substrate:	gravel to small cobble size rock, some larger rocks and boulders
Type 2	Good salmonid rearing habitat with limited spawning, usually only in isolated gravel pockets. Provides good feeding and holding areas.
flows:	heavier riffles to light rapids, current 0.3 to 1.0 m/s
depth:	variable from 0.3 to 1.5 m
substrate:	larger cobble/rubble size rock to boulders, some gravel pockets between larger rocks
Type 3	Good rearing habitat with no spawning capabilities, or used for migratory purposes.
flows:	very fast and turbulent, heavy rapids, chutes, small waterfalls, current > 1.0 m/s
depth:	variable, >1.5 m
substrate:	large rock and boulders, bedrock
Type 4	Poor juvenile salmonid rearing habitat with no spawning capability; may provide shelter and feeding habitat.
flows:	sluggish, currents <0.15 m/s
depth:	variable but often <0.5 m
substrate:	soft sediment or sand, occasionally large boulders or bedrock, aquatic macrophytes present in many locations
Type 5	No habitat available for rearing or spawning; usually too steep for fish access or intermittent headwater streams.
flows:	intermittent
depth:	variable <0.5 m
substrate:	variable from soft organic or gravel, cobble, sand

Table D4	**Left and Right Bank Slopes, Proposed Highway #104 Antigonish June 2002**			
Stream Crossing No.	Left Bank		Right Bank	
	Distance (m)	Slope (%)	Distance (m)	Slope (%)
1	6.5	15	2.7	25
0+100	11.7	14	12	2
	20	6	26	-3
	10	8	9	-5
2	6.2	15	3	45
0+800	3	3	3.5	27
	5	-3	(Existing Highway)	
	36	0		
3	5	0	50	2
1+400	7.3	10		
	42	2		
4	4.3	25	6.3	18
1+500	23	2	17.9	7
	25	1	23.8	0
5	5.4	4	14.5	4
2+600	5.7	7	13.1	9
	5.2	16	19.6	13
	5.4	30		
	10	31		
	9.8	32		
	10.5	26		
6	10.7	0	6	1
4+150	40	1	11	0
			10	1
			15	2
7	19.5	3	8	6
5+500	28	7	29.5	5
	2	2	12	7
8	5.9	3	3.4	35
5+700	5.1	26	11	3
	18	1	12.8	1
	4	18	12	1
			12	2
9	3	58	2.2	25
6+750	11.1	18	6.2	17
	15	8	15.6	4
	20	6	17	2
10	7.5	36	9.5	10
6+950	32	3	14	39
			13.1	26
			16.7	8
11	7	44	8	14
8+150	9	9	19	19
	14	2	25	10
	25	12		
12	50	1	10	1
9+000			15	2
			22	1
13	4	20	6	14
10+200	4.4	45	4	26
	10	9	5	14
	9	5	8	7
	11.5	6	12	6
	20	4		
14	1.3	47	1	55
10+850	28	4	20	2
	17.7	0	17	18
	11	12	10	7
15	35	2	10	1
14+600	15	1	20	2
			20	2

Table D5 Unnamed Brierly Brook Tributary (Stream Crossing No.1) Fish Habitat Summary

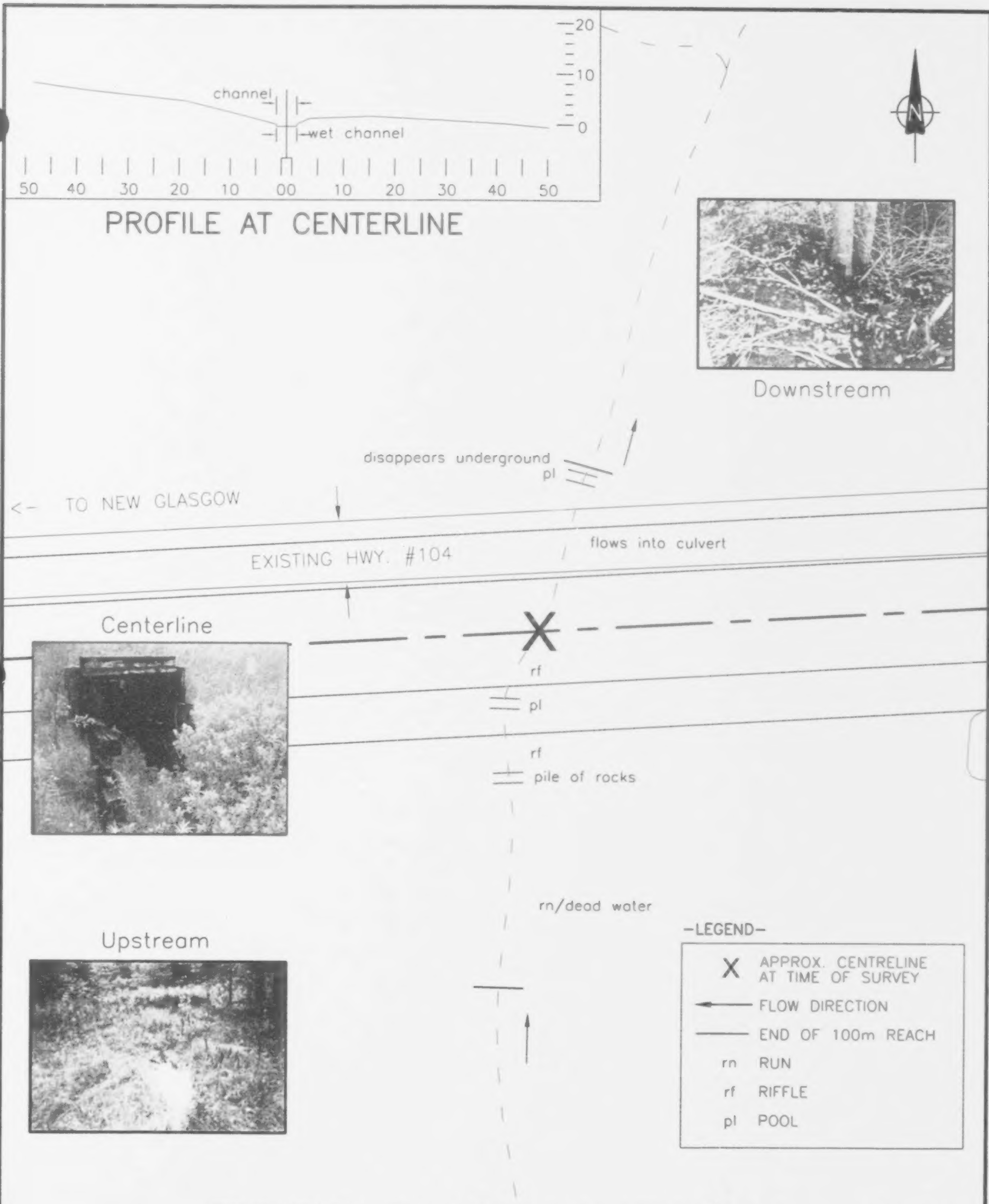
Aquatic Habitat Evaluation at ROW (0+100)	
Physical Units	Stream
Substrate	10% boulder, 40% cobble, 25% sand, 25% silt
Embeddedness	>50%
Mean Depth (cm)	12cm
Dimensions (m)	wet width 0 - 0.55m, channel width 1m
Bank Stability	50%-75 %
Overhead Cover	0%-20%
Bank Cover	grasses, sedges and rushes - 10%
Instream Cover	sparse 0%-25%
Physical Observations and Habitat Type	
Conductivity (FS/cm)	34
Flow (m^3/s)	Not possible to calculate
Water Colour	colourless
pH	6.9
Temperature (°C)	14
Fish and Fish Habitat	No fish seen. Was not electrofished due to small size, low conductivity and apparent lack of habitat. Type 5 salmonid habitat.

Table D6 Unnamed Brierly Brook tributary (Stream Crossing No. 1) Erosion Sensitivity Level

Bank	Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Dark reddish brown clay-sand, some organic and gravel	moderate	15% – 8%	low	Moderate - low
Right	Dark reddish brown clay-sand with some organic and gravel	moderate	25% - (-5)%	moderate	moderate

*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.

Slope class: negligible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 1

SCALE 1: 1000

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Table D7 Unnamed Stream (Stream Crossing No.2)
Fish Habitat Summary

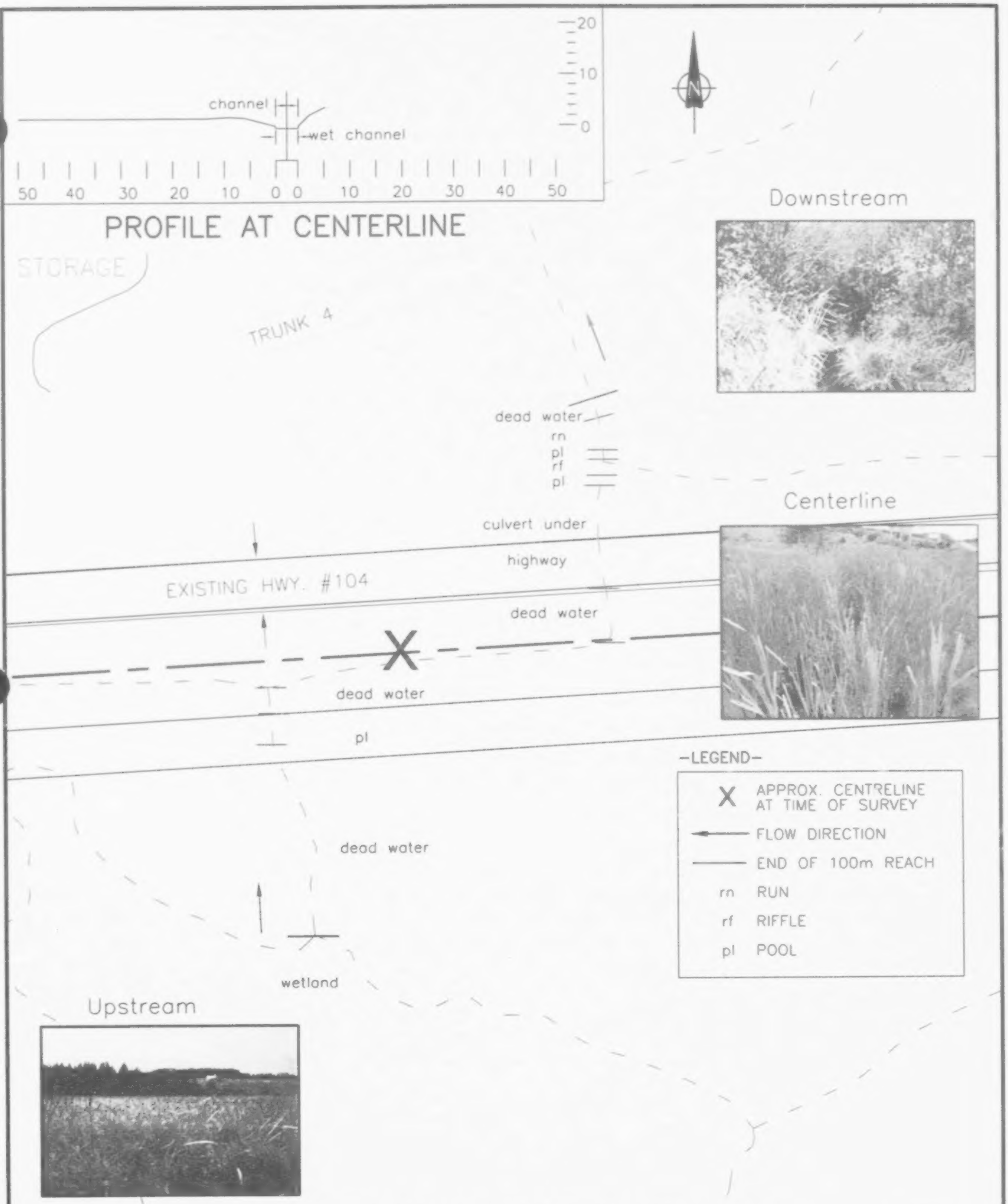
Aquatic Habitat Evaluation at ROW (0+800)	
Physical Units	Marsh drainage - stream
Substrate	Silt, 100%
Embeddedness	>50%
Mean Depth (cm)	40cm
Dimensions (m)	3.9m – wet width, 4.4m – channel width
Bank Stability	75%-100%
Overhead Cover	0%-20%
Bank Cover	Grasses, cattails and water horsetail – 15%
Instream Cover	Cattails and filamentous algae, some sections almost completely dominated with Typhus. Spp. (25% – 75%)
Physical Observations and Habitat Type (not available due to absence of flow)	
Conductivity (FS/cm)	168
Flow (m^3/s)	N/A
Water Colour	brown
pH	5.54
Temperature (°C)	15.9
Fish and Fish Habitat	Brief electrofishing in open water at culvert yielded no specimens, poor footing and heavy vegetative cover limited electrofishing access in the marsh. This marsh has been identified as important overwintering habitat for brook trout (D. Goth, pers. comm. 2002) The stream also is likely important in maintaining the natural hydrologic function of its origin wetland. This site is rated based on morphology, substrate and habitat characteristics as Type 3 slamonid habitat.

Table D8 Unnamed Stream (Stream Crossing No.2)
Erosion Sensitivity Level

Bank	Particle Size Class and % Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Dark reddish brown sandy clay with sandstone gravel, root hairs and roots.	moderate	15%-(-3)%	low	low
Right	Dark reddish brown silty clay sand, with some fine gravel	high	45% – 27%	high	high

*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.

Slope class: negligible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 2

SCALE 1: 1000

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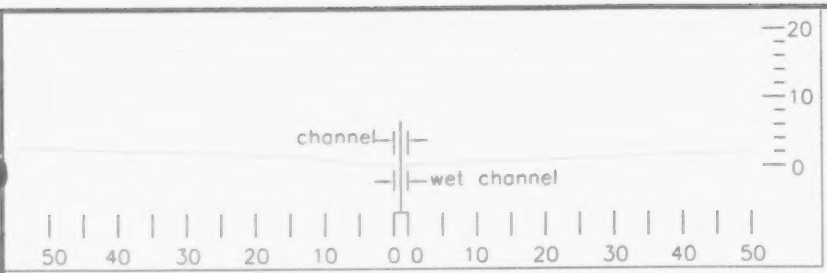
Table D9 Unnamed Stream (Stream Crossing No.3)
Fish Habitat Summary

Aquatic Habitat Evaluation at ROW (1+400)	
Physical Units	Intermittent marshy stream
Substrate	100% silt
Embeddedness	>50%
Mean Depth (cm)	5cm
Dimensions (m)	Undefined standing water marsh habitat, no definable stream morphology at time of survey
Bank Stability	75%-100%
Overhead Cover	20%-50%
Bank Cover	Water horsetail, grey alder and cattails – 15%
Instream Cover	Cattails, rushes and water horsetail (25%-75%)
Physical Observations and Habitat Type (not available due to absence of flow)	
Conductivity (FS/cm)	1012
Flow (m^3/s)	NA - due to low water conditions at time of survey
Water Colour	colourless
pH	6.8
Temperature (°C)	16.4
Fish and Fish Habitat	Although not characteristic, preferred trout habitat, this site is connected to the marsh that has been outlined as overwintering trout habitat(DFO). Electrofishing was not possible due to the limiting morphological dimensions of the stream at time of survey. Based on morphology and habitat characteristics this stream denotes a salmonid habitat rating of Type 5.

Table D10 Unnamed Stream (Stream Crossing No.3)
Erosion Sensitivity Level

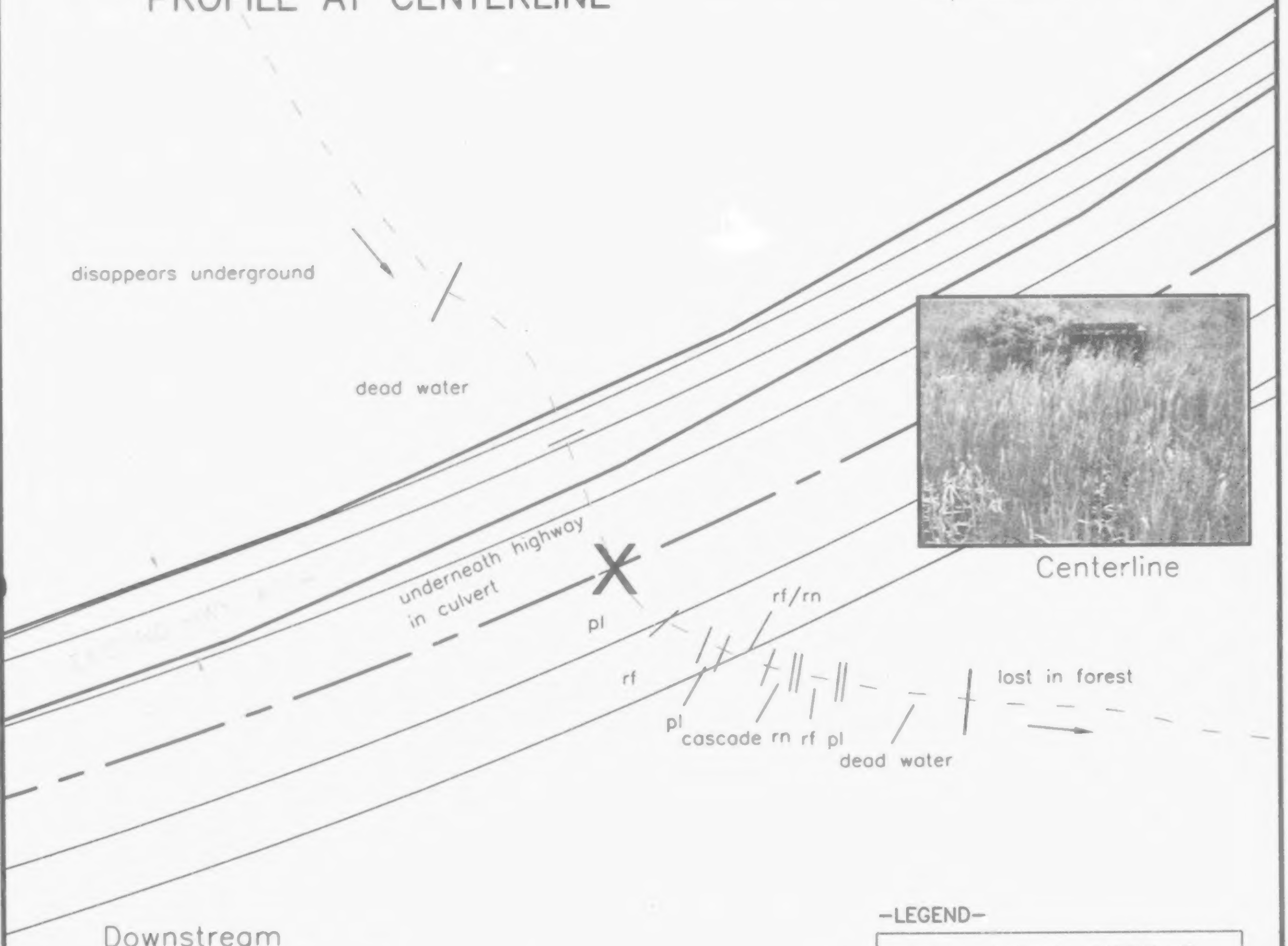
Bank	Particle Size Class and % Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Dark reddish brown clay sand with gravel.	moderate	10%	negligible	low
Right	Dark reddish brown clay silt sand with gravel and root hairs.	moderate	2%	negligible	low

*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.
Slope class: negligible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



PROFILE AT CENTERLINE

Upstream



Centerline

Downstream

-LEGEND-

X	APPROX. CENTRELINE AT TIME OF SURVEY
←	FLOW DIRECTION
—	END OF 100m REACH
rn	RUN
rf	RIFFLE
pl	POOL

APP'D

TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 3

SCALE 1: 1000

Table D11 Unnamed Stream (Stream Crossing No.4)
Fish Habitat Summary

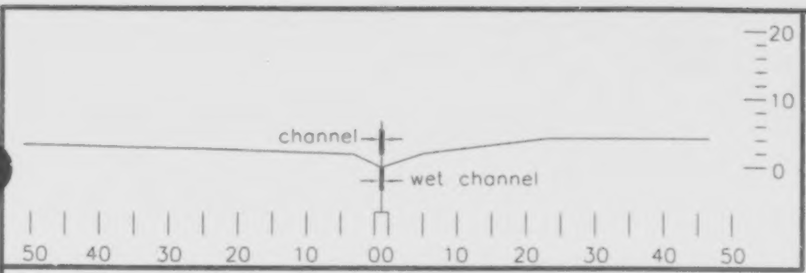
Aquatic Habitat Evaluation at ROW (1 + 500)	
Physical Units	Marshy stream with standing water (concrete culvert at existing highway)
Substrate	Cobble 30%, sand 50%, silt 20%
Embeddedness	>50%
Mean Depth (cm)	30cm
Dimensions (m)	0.45m below culvert, 2-3m standing water above culvert
Bank Stability	75%-100%
Overhead Cover	0%-20%
Bank Cover	Grammanoid spp., buttercups, water horsetails and grey alder, 15%
Instream Cover	Horsetails and cattails, some woody debris (0-20%)
Physical Observations and Habitat Type	
Conductivity (FS/cm)	1830
Flow (m^3/s)	NA (due to standing nature of water and shallow gradient)
Water Colour	yellow
pH	6
Temperature (°C)	16
Fish and Fish Habitat	No fish or fish habitat at time of survey. As with crossing 3 this site does flow from the marsh identified as salmonid overwintering habitat. Type 3 Salmonid habitat.

Table D12 Unnamed Tributary (Stream Crossing No.4)
Erosion Sensitivity Level

Bank	Particle Size Class and % Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Dark reddish brown clay sand with coarse gravel.	moderate	25% – 1%	moderate	moderate
Right	Dark reddish brown clay sand to sand clay with gravel.	moderate	7% – 18%	moderate	moderate

*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.

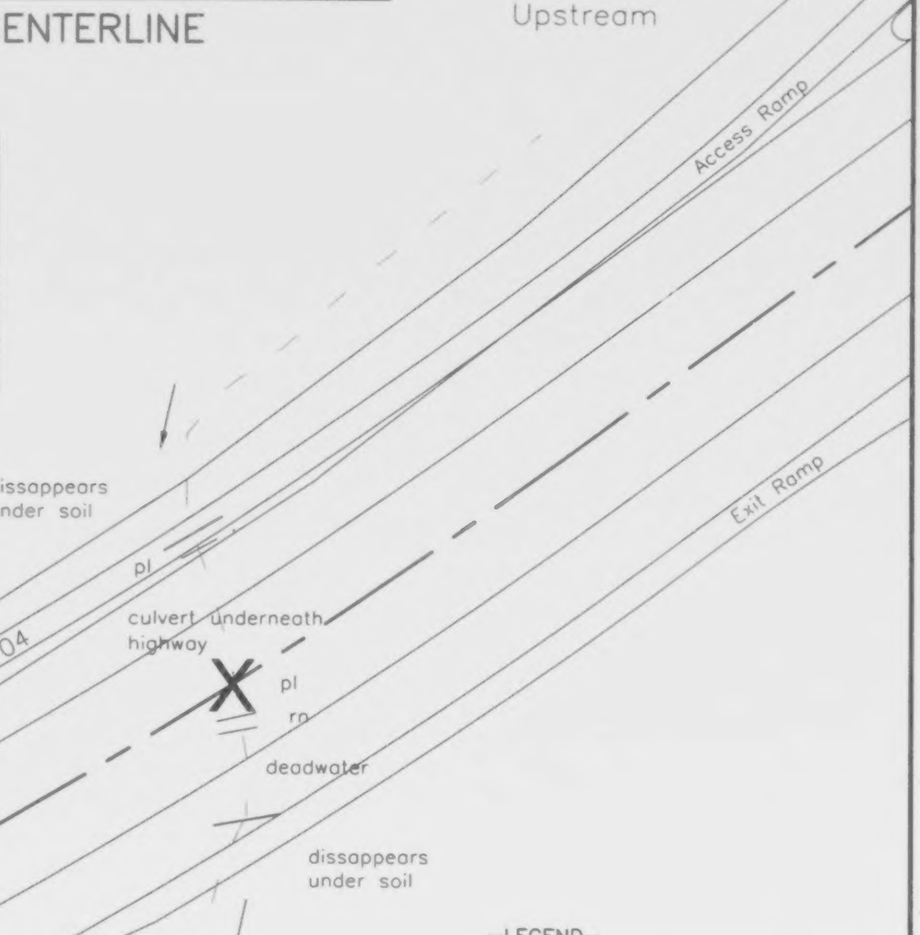
Slope class: negligible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



PROFILE AT CENTERLINE

Upstream

Centerline



-LEGEND-

X	APPROX. CENTRELINE AT TIME OF SURVEY
←———	FLOW DIRECTION
———	END OF 100m REACH
rn	RUN
rf	RIFFLE
pl	POOL

Downstream

TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 4

SCALE 1:1000

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Table D13 Unnamed Stream (Stream Crossing No. 5)
Fish Habitat Summary

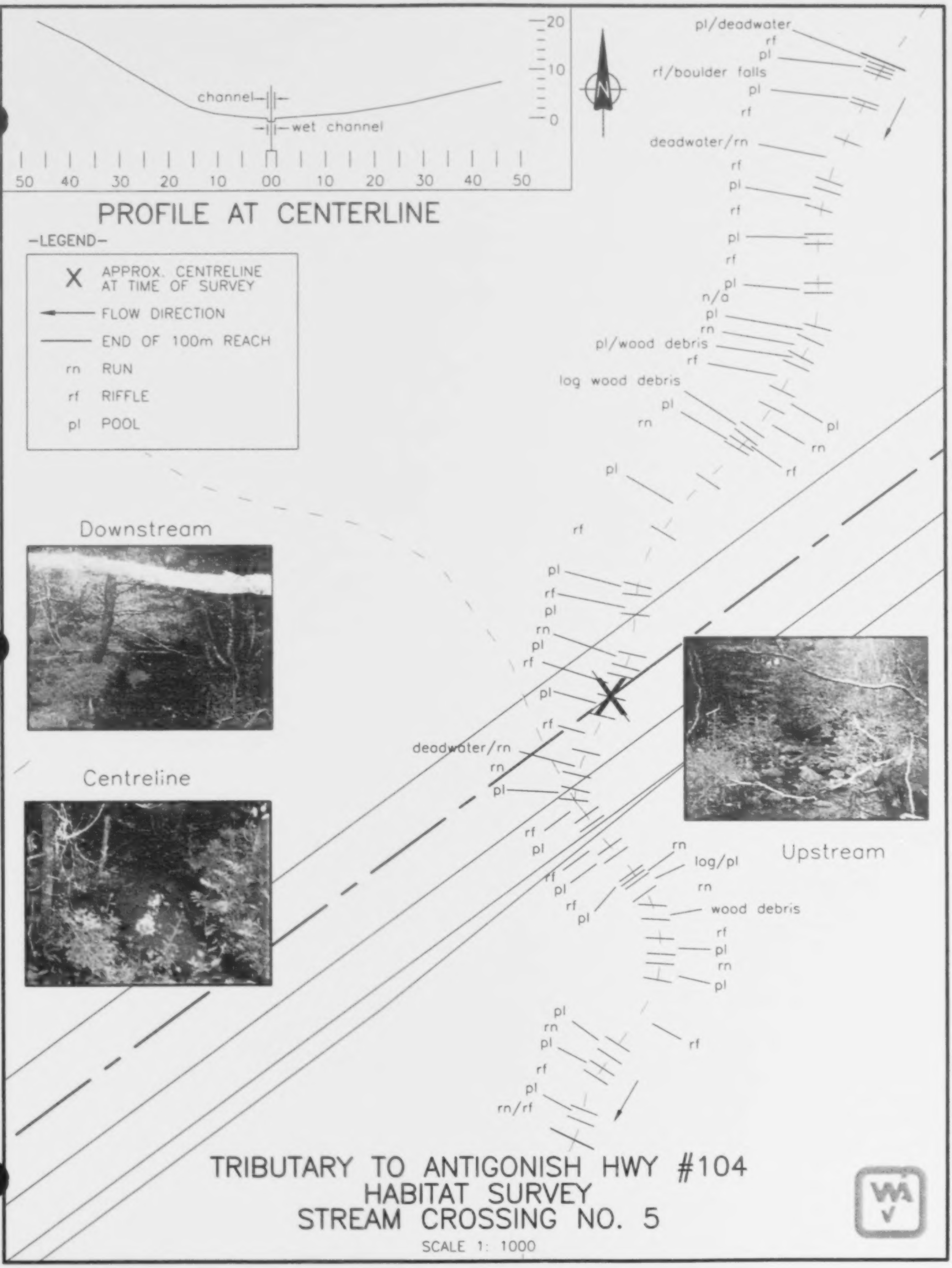
Aquatic Habitat Evaluation at ROW (2 + 600)	
Physical Units	Small brook
Substrate	40% boulder, 20% cobble, 40% silt
Embeddedness	20%-35%
Mean Depth (cm)	4cm
Dimensions (m)	0.60m wet width, 1.5m channel width
Bank Stability	50%-75%
Overhead Cover	Black spruce, and grey alder – (50%)
Bank Cover	Club moss, black spruce, sensitive fern - (20%)
Instream Cover	Woody debris, sparse (0-20%)
Physical Observations and Habitat Type	
Conductivity (FS/cm)	411
Flow (m^3/s)	NA (not enough water to calculate)
Water Colour	colourless
pH	6.6
Temperature (°C)	12
Fish and Fish Habitat	Salmonid habitat rating of Type 3. Heavy siltation and low discharge would limit the potential for spawning habitat. Although there would be a possibility that the habitat could be utilized in a transitory nature by brook trout and cyprinides.

Table D14 Unnamed brook (Stream Crossing No.5)
Erosion Sensitivity Level

Bank	Particle Size Class and % Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Dark reddish silty clay sand, some organic	moderate	4% – 32%	high	Moderate - high
Right	Dark reddish silty clay sand, somw organic with lower moisture content than left side.	moderate	4%– 13%	low	Moderate - low

*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.

Slope class: negligible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



PROFILE AT CENTERLINE

-LEGEND-

X	APPROX. CENTRELINE AT TIME OF SURVEY
←——	FLOW DIRECTION
——	END OF 100m REACH
rn	RUN
rf	RIFFLE
pl	POOL

TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 5

SCALE 1: 1000

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Table D15 Unnamed Stream (Stream Crossing No.6)
Fish Habitat Summary

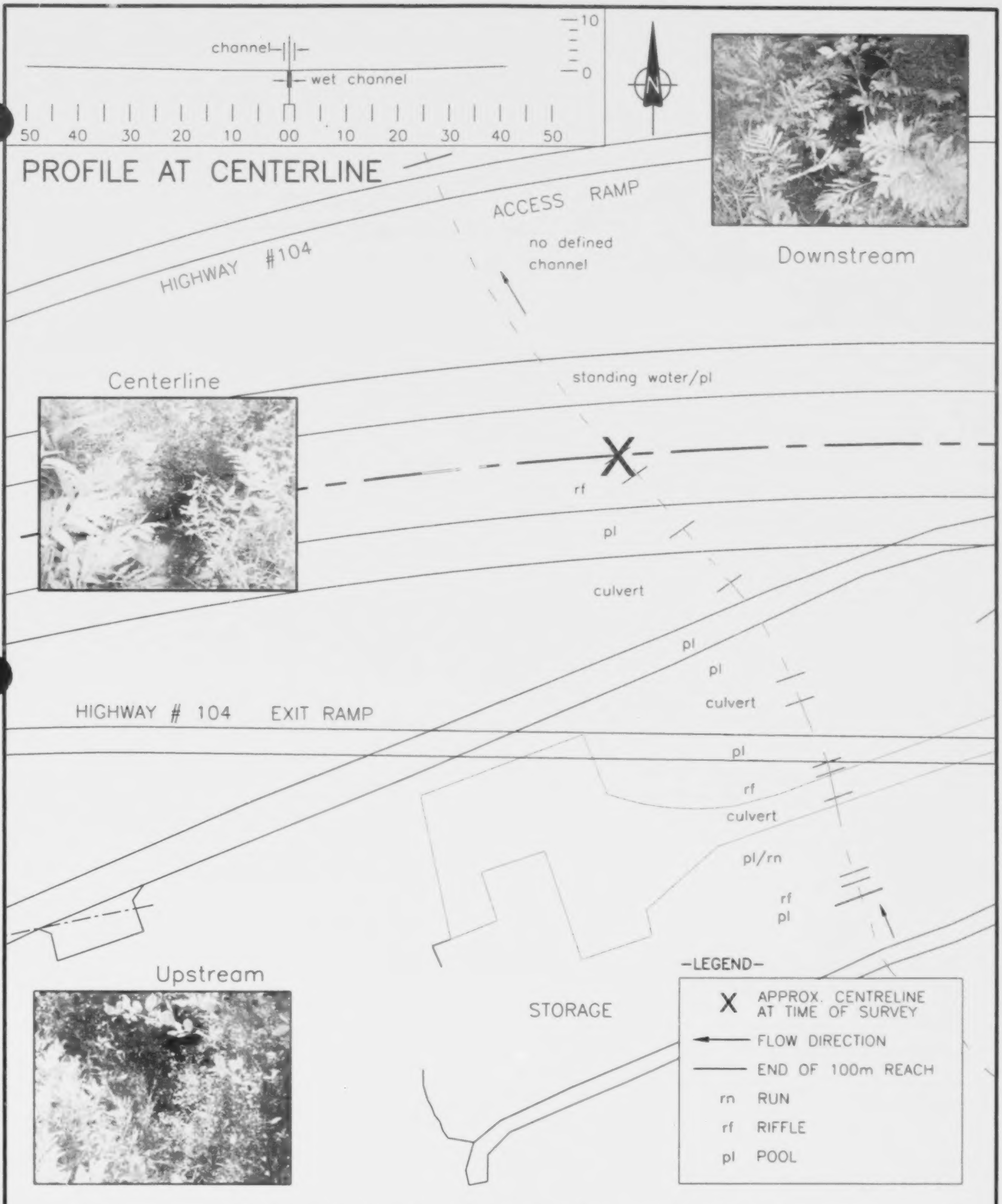
Aquatic Habitat Evaluation at ROW (4+150)	
Physical Units	Stream in low lying marshy area
Substrate	100% Silt
Embeddedness	>50%
Mean Depth (cm)	7cm
Dimensions (m)	Wet width 0.4m, Channel width 0.62m
Bank Stability	50% - 75%
Overhead Cover	20% -50%, grey alders
Bank Cover	Black spruce, sensitive fern, grammanoid spp., 10 %
Instream Cover	Woody debris, (20%)
Physical Observations and Habitat Type	
Conductivity (FS/cm)	658
Flow (m^3/s)	NA – due to low water conditions at time of survey
Water Colour	colourless
pH	6.5
Temperature (°C)	15
Fish and Fish Habitat	This site had heavy siltation and high turbidity. The salmonid habitat was marginal and classified as Type 4. Electrofishing did yield four three-spine sticklebacks and one nine-spine stickleback. Four-spine stickleback and northern redbelly dace have also been observed in this brook (Taylor and Juurlink 2004).

Table D16 Unnamed Stream (Stream Crossing No.6)
Erosion Sensitivity Level

Bank	Particle Size Class and % Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Dar reddish brown silty clay sand. Slightly wet with minimal organics	moderate	1%	negligible	low
Right	Same as left with higher organic content.	moderate	1% - 2%	negligible	low

*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.

Slope class: negligible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 6

SCALE 1: 1000

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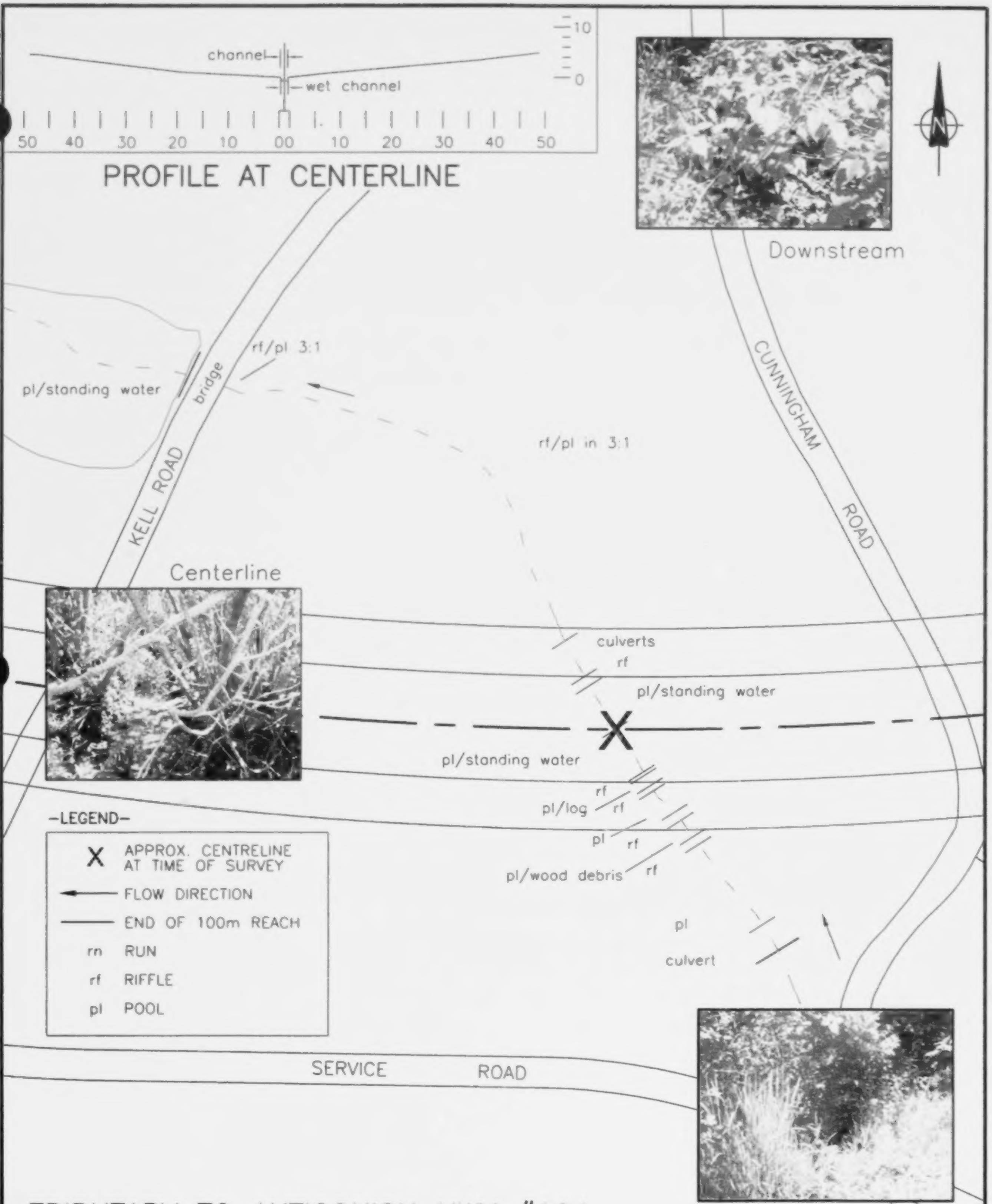
Table D17 Unnamed Stream (Stream Crossing No.7) Fish Habitat Summary	
Aquatic Habitat Evaluation at ROW (5 + 500)	
Physical Units	Small turbid steam, with heavy sinuosity and standing water.
Substrate	100% Silt
Embeddedness	>50%
Mean Depth (cm)	4cm
Dimensions (m)	0.85 wet width, 1.45 channel width
Bank Stability	50%-75%
Overhead Cover	0%-20% some small soft woods
Bank Cover	Grey alder and thistle, 10%
Instream Cover	Woody debris and macrophytes (0%-20%)
Physical Observations and Habitat Type	
Conductivity (FS/cm)	300
Flow (m^3/s)	NA – due to low water conditions at time of survey.
Water Colour	brown
pH	7.1
Temperature (°C)	16.1
Fish and Fish Habitat	This stream was assessed as Type 3 salmonid habitat. Electrofishing was not conducted because of lack of sufficient water volume.

Table D18 Unnamed Stream (Stream Crossing No.7) Erosion Sensitivity Level

Bank	Particle Size Class and % Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Dark reddish brown silty clay sand with gravel and root hairs	moderate	2%-7%	low	low - moderate
Right	Same as left with smaller gravel component.	moderate	5%-7%	low	low - moderate

*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.

Slope class: negligible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 7

SCALE 1: 1000

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Table D19 West River Antigonish (Stream Crossing No.8)
Fish Habitat Summary

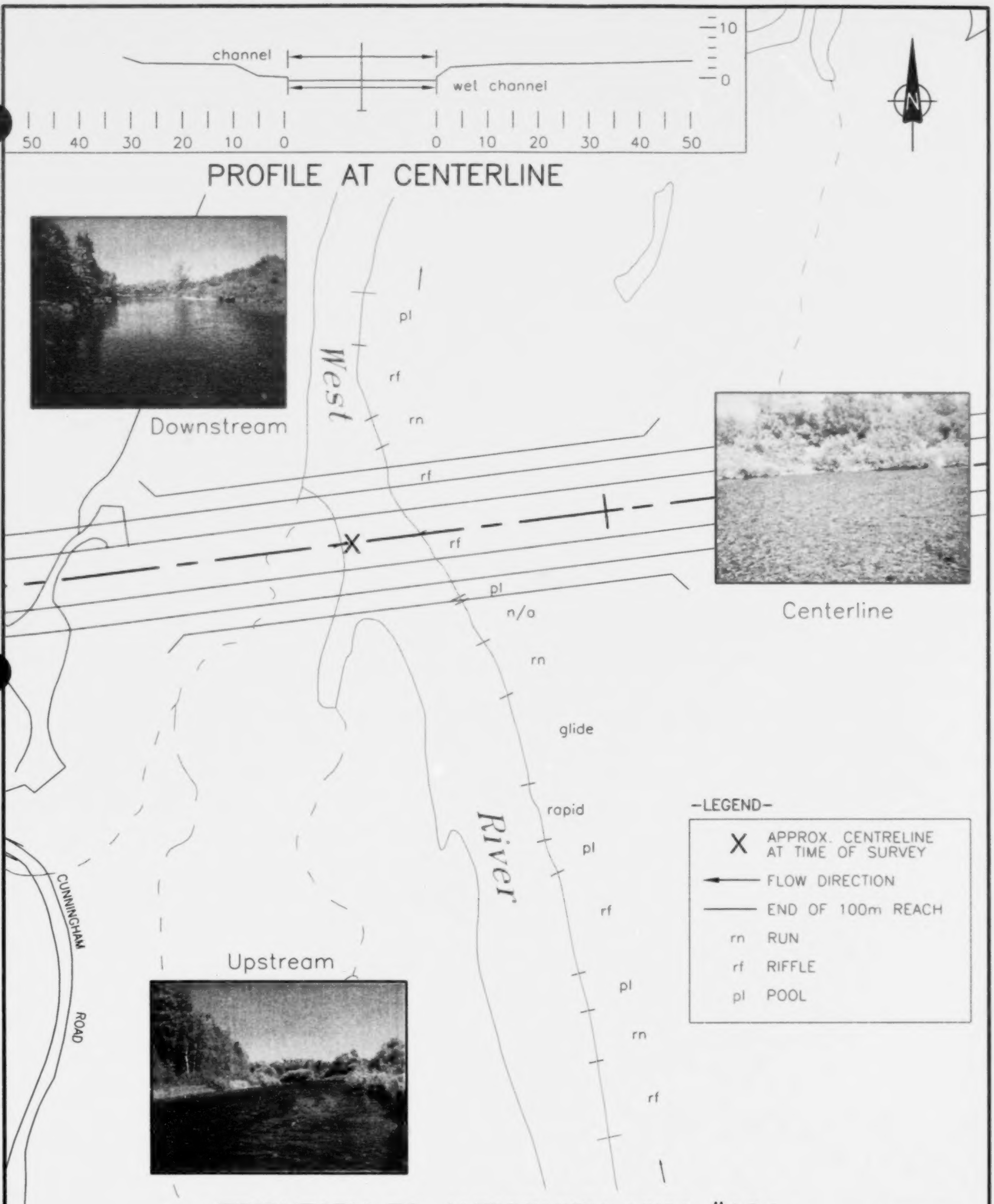
Aquatic Habitat Evaluation at ROW (5 +700)	
Physical Units	River - riffle at ROW
Substrate	Boulder 15%, cobble 75%, gravel 10%
Embeddedness	0% - 20%
Mean Depth (cm)	avg. depth at ROW = 30cm
Dimensions (m)	24m wet width, 29m channel width
Bank Stability	50%-75% (20% undercutting on west bank)
Overhead Cover	0%-20%, partially cleared at ROW
Bank Cover	Grasses, alders and grammanoid species - 10%
Instream Cover	Boulders, woody debris and filamentous algae, 20%
Physical Observations and Habitat Type	
Conductivity (FS/cm)	447
Flow (m^3/s)	4.39m^3/s, corrected surface velocity = 0.61m/s , crossectional area = 7.20m^2
Water Colour	Clear
pH	5.85
Temperature (°C)	15.7
Fish and Fish Habitat	The West River is one of Nova Scotia's premiere fall salmon recreational fisheries. Atlantic salmon, brown trout and brook trout all inhabit the system along with a host of cyprinides and sticklebacks species which include: northern red-belly dace, creek chub, banded killifish, common white sucker, three spine stickleback, and nine-spine stickleback, all of which were sampled during electrofishing at the ROW (see electrofishing results). The ROW crossing is an example of highly productive riffle habitat. Small pools below the riffle were heavily populated with Atlantic salmon parr, and can be classified as excellent rearing and potential spawning habitat for salmonids especially Atlantic Salmon. The electrofishing was confined to the ROW and the results did not show the presence of either brown or brook trout. This could possibly be explained because of the dominance Atlantic salmon parr at the ROW. Both brown and brook trout do however have strong populations in the river (D. Goth, pers. comm. 2002) The West River is rated as Type 1 salmonid habitat.

Table D20 West River Antigonish (Stream Crossing No.8)
Erosion Sensitivity Level

Bank	Particle Size Class and % Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Dark reddish brown silty sand. With some organics.	high	1% - 26%	moderate	Moderate - high
Right	Same as left.	moderate	1% - 35%	high	Moderate - high

*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.

Slope class: neglible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 8

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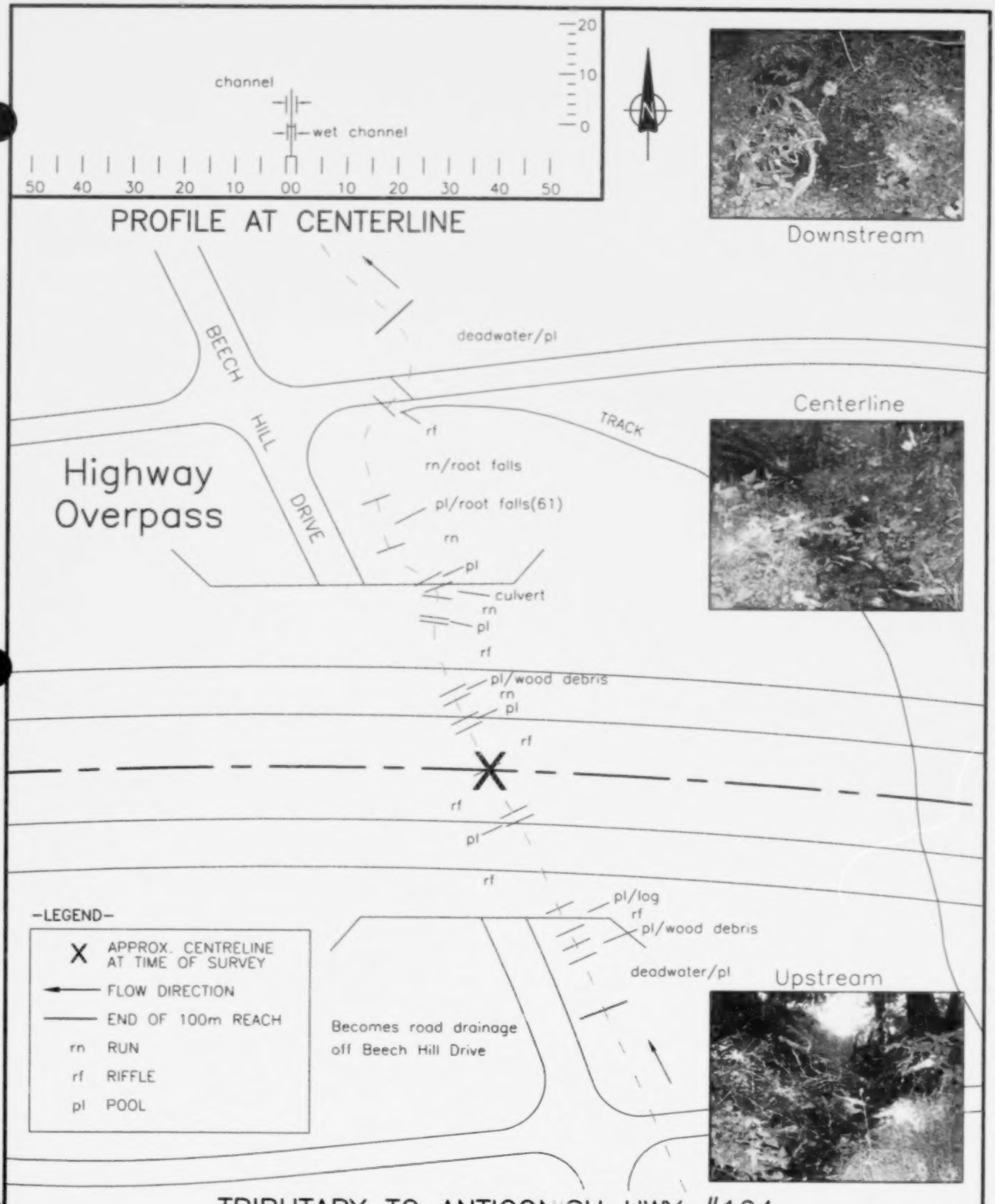
Table D21 Unnamed Stream (Stream Crossing No.9)
Fish Habitat Summary

Aquatic Habitat Evaluation at ROW (6 +750)	
Physical Units	Intermittent boggy stream
Substrate	Boulder 10%, Cobble 60%, Gravel 20%, Silt 10%
Embeddedness	25%
Mean Depth (cm)	3cm
Dimensions (m)	1.5m channel width
Bank Stability	75%-100% (banks 25% undercut)
Overhead Cover	Black spruce (30%)
Bank Cover	Mosses, ferns ~5%
Instream Cover	Undercut banks sparse(0%-20%)
Physical Observations and Habitat Type	
Conductivity (FS/cm)	382
Flow (m^3/s)	NA – due to absence of flowing water
Water Colour	Colourless
pH	6.88
Temperature (°C)	13.6
Fish and Fish Habitat	Type 5 salmonid habitat, - intermittent nature, lack of definable morphology and low flow combine to create poor potential salmonid rearing or spawning habitat.

Table D22 Unnamed Stream(Stream Crossing No.9)
Erosion Sensitivity Level

Bank	Particle Size Class and % Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Dark reddish brown clay sand with gravel and root hairs.	moderate	2%-35%	high	Moderate-high
Right	Same as left but with no gravel.	moderate	6%-58%	Very high	high

*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.
Slope class: negligible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 9

SCALE 1: 1000

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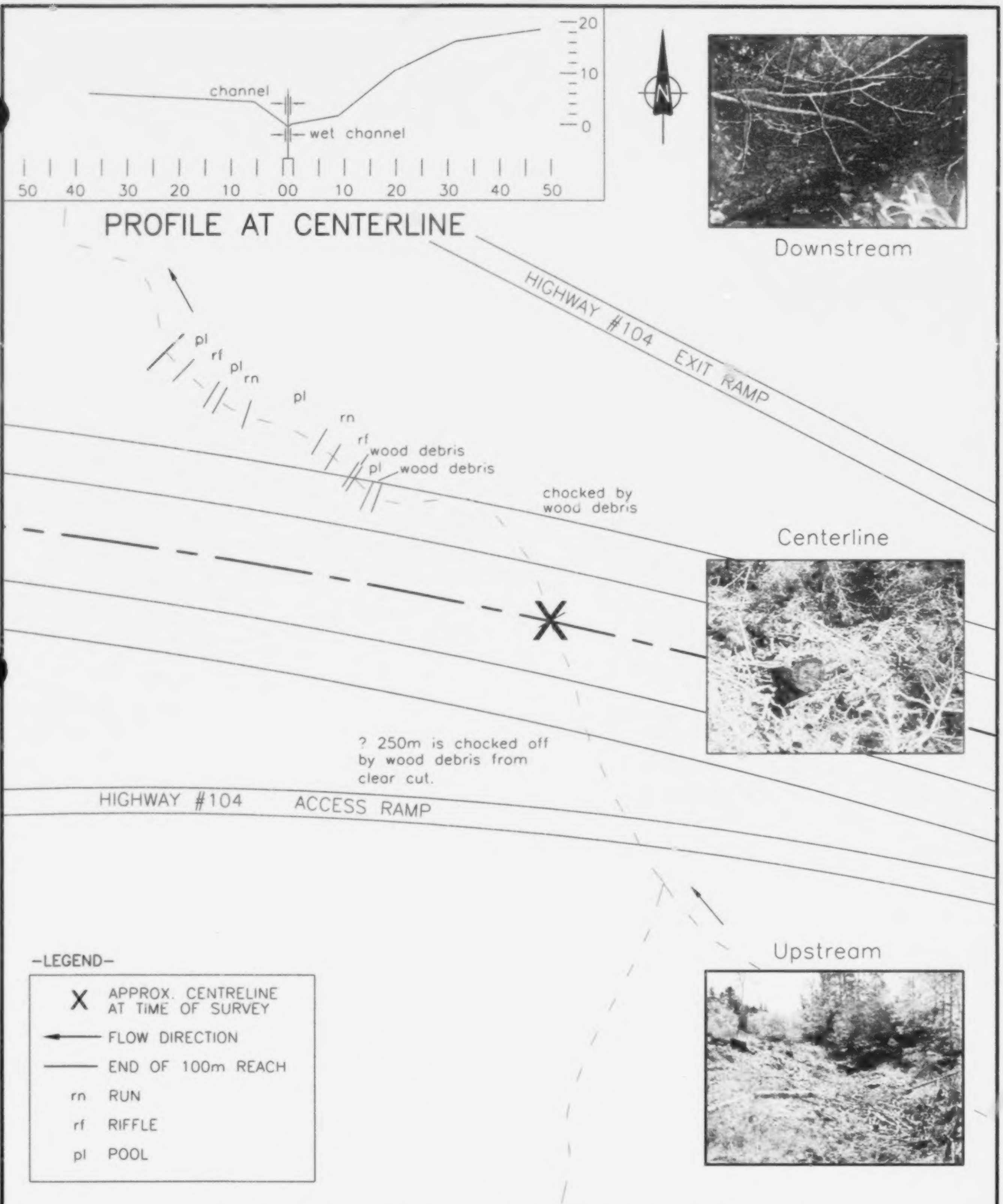
Table D23 Unnamed Stream (Stream Crossing No.10)
Fish Habitat Summary

Aquatic Habitat Evaluation at ROW (6 + 950)	
Physical Units	Small meandering stream – (completely clogged with logging slash at ROW)
Substrate	Cobble 30%, Gravel 40%, silt 30%
Embeddedness	>50%
Mean Depth (cm)	7cm
Dimensions (m)	0.40m wet width, 1m channel width
Bank Stability	75%-100%
Overhead Cover	0%-20%
Bank Cover	logged and eroded banks
Instream Cover	Steam bed completely covered with slash , dense >75%
Physical Observations and Habitat Type (not available due to absence of flow)	
Conductivity (FS/cm)	65
Flow (m^3/s)	NA – due to absence of water velocity
Water Colour	Colourless
pH	7.2
Temperature (°C)	16
Fish and Fish Habitat	Stream greatly affected by poor logging practice, which have increased erosion and sedimentation. This stream was classified as Type 4 salmonid habitat at the time of survey. In periods of greater discharge, this stream could potentially provide marginal habitat for salmonid species. However the stream could be utilized for migratory purposes and has important hydrologic function for the health of the parent watershed (*i.e.* West River)

Table D24 Unnamed Stream (Stream Crossing No.10)
Erosion Sensitivity Level

Bank	Particle Size Class and % Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Dark reddish brown silty sand with gravel, some organics	high	36%-3%	high	high
Right	Same as left, slightly higher moisture content.	high	8%-39%	high	high

*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.
Slope class: negligible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 10

SCALE 1: 1000

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Table D25 Unnamed Stream (Stream Crossing No.11)
Fish Habitat Summary

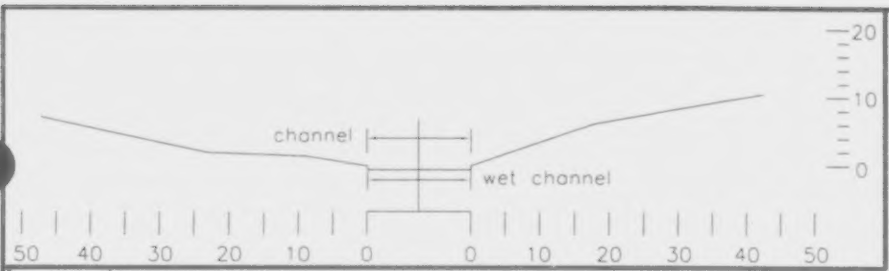
Aquatic Habitat Evaluation at ROW (8 +150)	
Physical Units	Still water section of small meandering stream, Beaver dam 40 m below center line.
Substrate	Silt 100%
Embeddedness	>50%
Mean Depth (cm)	0.50m
Dimensions (m)	Still water dimension –15m
Bank Stability	0%-50% toppled trees and slumping
Overhead Cover	0%-20% Riparian zone completely logged
Bank Cover	Grasses, gramanoid spp. and small red spruce,)5%-20%
Instream Cover	Lilles, woody debris – 15%
Physical Observations and Habitat Type	
Conductivity (FS/cm)	225
Flow (m^3/s)	NA – due to absence of water velocity
Water Colour	Brown
pH	6.38
Temperature (°C)	18.6
Fish and Fish Habitat	Downstream of the ROW was electrofished to assess the species composition of the brook since a beaver dam created a large pool of water at the ROW. All morphological features were spot electrofished. During electrofishing it was noted that severe damage to the riparian zone had resulted in increased sedimentation and loss of fish habitat. Apparent trout habitat was devoid of salmonid presence. The results did however yield some cyprinide and stickleback species that included; northern redbelly dace, common white sucker, creek chub, three spine stickleback and nine-spine sticklebacks (see electrofishing results). Increased sedimentation and photic exposure, a result of logging, has likely changed stream from a cold water stream with salmonid sustaining DO levels to a cool water stream with marginal DO levels. The absence of brook trout in the electrofishing results is likely a result of the species being pushed to more thermally and oxygen stable areas of the brook such as areas influenced by ground water discharge. This habitat rates as Type 2 salmonid habitat although has been compromised by logging influence.

Table D26 Unnamed Stream (Stream Crossing No.11)
Erosion Sensitivity Level

Bank	Particle Size Class and % Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Dark reddish brown silty sand with gravel, with some organics.	high	12%-44%	high	high
Right	Same as left	high	10%-14%	low	moderate

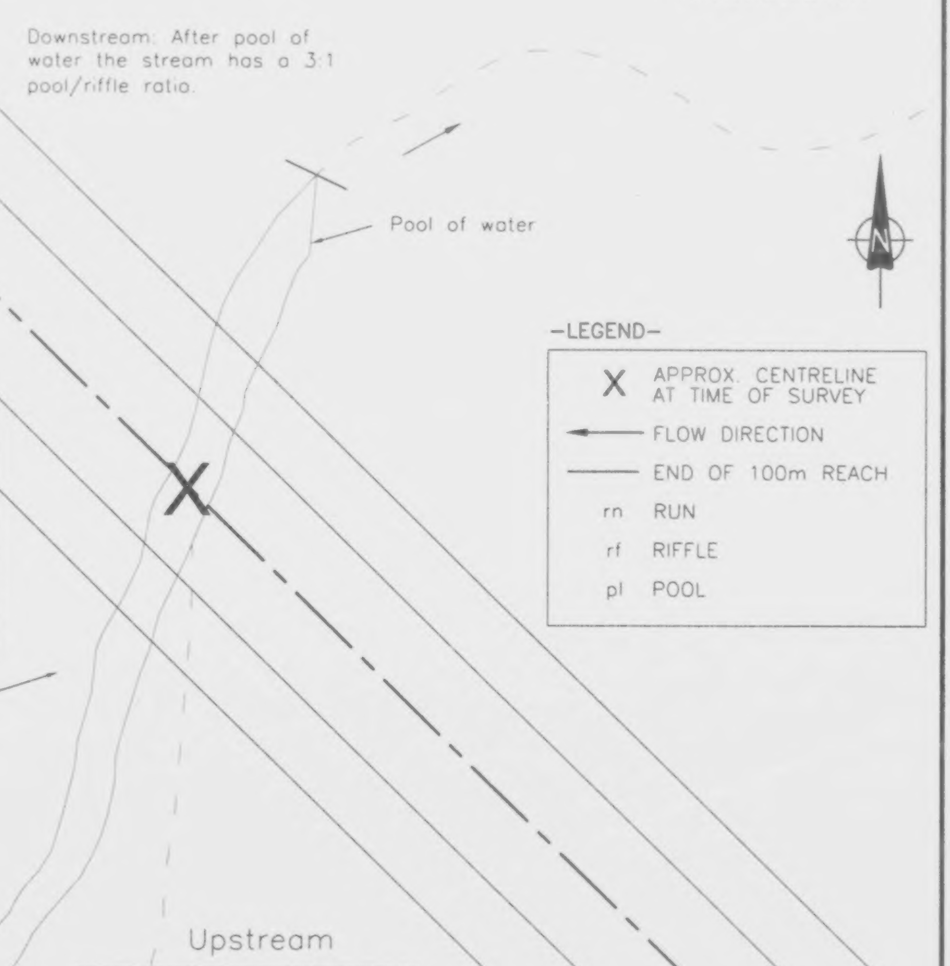
*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.

Slope class: negligible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



PROFILE AT CENTERLINE

Downstream



Downstream: After pool of water the stream has a 3:1 pool/riffle ratio.

-LEGEND-

X	APPROX. CENTRELINE AT TIME OF SURVEY
←	FLOW DIRECTION
—	END OF 100m REACH
rn	RUN
rf	RIFFLE
pl	POOL

Centerline

Upstream=Wetland

Upstream

TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 11

SCALE 1: 1000

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Table D27 Unnamed Stream (Stream Crossing No. 12)
Fish Habitat Summary

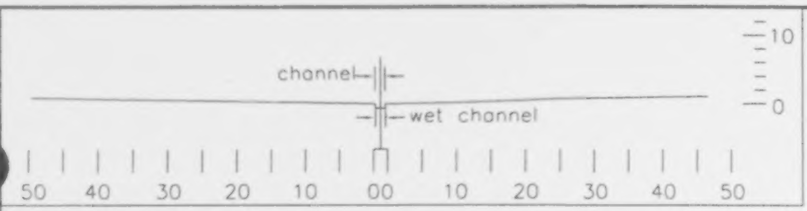
Aquatic Habitat Evaluation at ROW (9 +000)	
Physical Units	Marshy ditch, choked with decaying plant matter
Substrate	Silt 100%
Embeddedness	>50%
Mean Depth (cm)	5cm
Dimensions (m)	1.1m wet width, 1.4m channel width
Bank Stability	50%-75%
Overhead Cover	Alder, cattails 0%-20%
Bank Cover	Wild red raspberry, grey alder, grasses and cattails (15%)
Instream Cover	Cattails (25%)
Physical Observations and Habitat Type	
Conductivity (FS/cm)	450
Flow (m^3/s)	NA – due to absence of water velocity
Water Colour	Yellow
pH	6.8
Temperature (°C)	19.3
Fish and Fish Habitat	Type 5 salmonid habitat at time of survey. Not electrofished because of small physical dimensions and heightened water temperatures. No fish were seen during the survey, although it does have the potential to host fish during periods of greater discharge.

Table D28 Unnamed Stream (Stream Crossing No. 12)
Erosion Sensitivity Level

Bank	Particle Size Class and % Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Black organic silt/peat	high	1%	negligible	low-moderate
Right	Black peat	high	2%	negligible	low-moderate

*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.

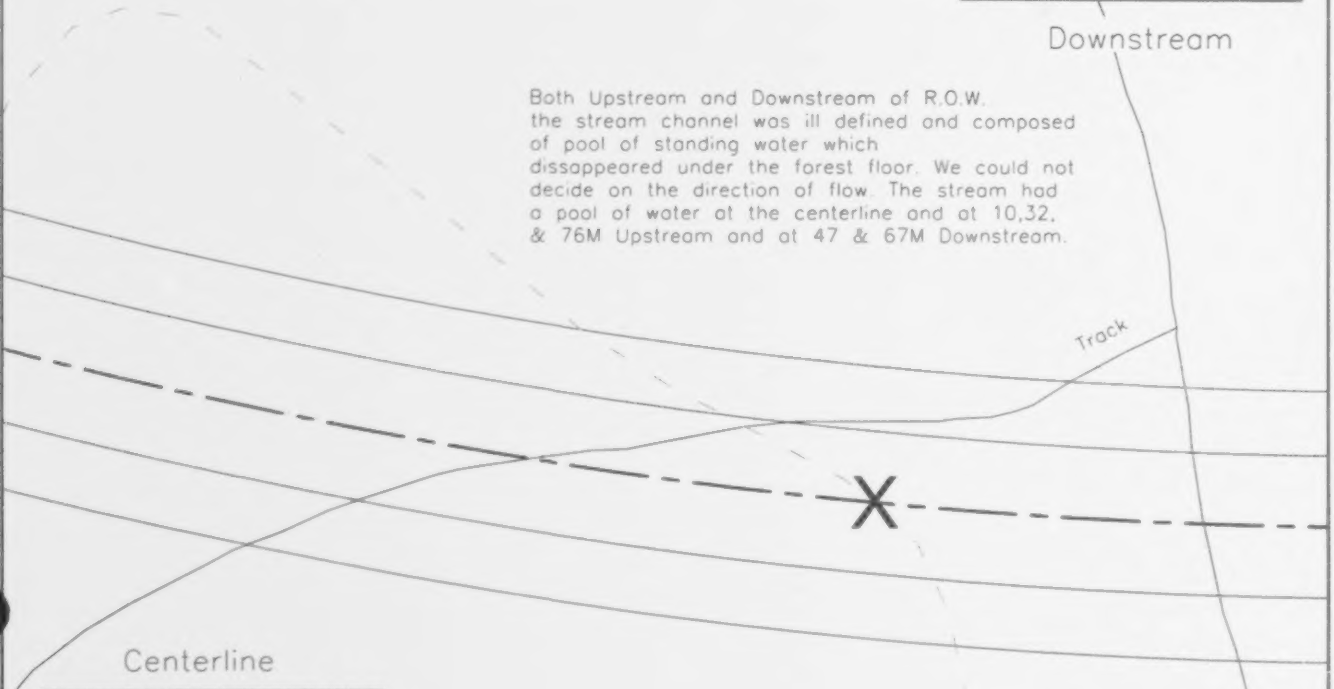
Slope class: negligible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



PROFILE AT CENTERLINE

Downstream

Both Upstream and Downstream of R.O.W. the stream channel was ill defined and composed of pool of standing water which dissappeared under the forest floor. We could not decide on the direction of flow. The stream had a pool of water at the centerline and at 10,32, & 76M Upstream and at 47 & 67M Downstream.



Centerline

-LEGEND-

X	APPROX. CENTRELINE AT TIME OF SURVEY
←——	FLOW DIRECTION
———	END OF 100m REACH
rn	RUN
rf	RIFFLE
pl	POOL

Upstream

TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 12

SCALE 1: 1000

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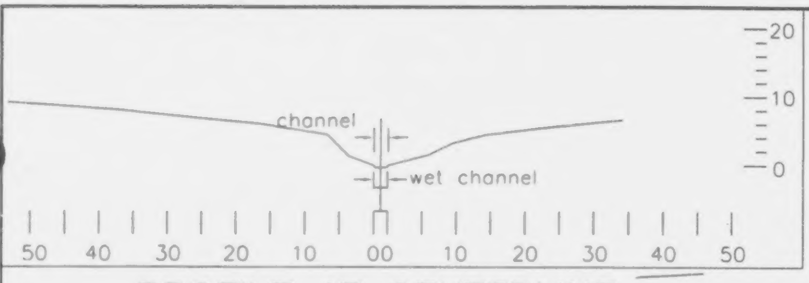
Table D29 Unnamed Stream (Stream Crossing No.13)
Fish Habitat Summary

Aquatic Habitat Evaluation at ROW (10 +200)	
Physical Units	Ditch (completely dry at time of survey)
Substrate	Boulder 60%, rubble 40%
Embeddedness	0-20%
Mean Depth (cm)	Dry
Dimensions (m)	Undefinable due to overgrowth at time of survey
Bank Stability	75%-100%
Overhead Cover	Black spruce, choke cherry, gery alder 25%-50%
Bank Cover	NA
Instream Cover	NA
Physical Observations and Habitat Type (not available due to absence of water)	
Conductivity (FS/cm)	N/A
Flow (m^3/s)	N/A
Water Colour	N/A
pH	N/A
Temperature (°C)	N/A
Fish and Fish Habitat	Type 5 for salmonid habitat.

Table D30 Unnamed Stream (Stream Crossing No.13)
Erosion Sensitivity Level

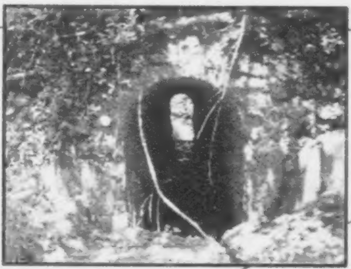
Bank	Particle Size Class and % Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Dark reddish brown silty sand, with some organics	high	4%-45%	high	high
Right	Same as left	moderate	6%-26%	moderate	moderate

*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.
Slope class: neglible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



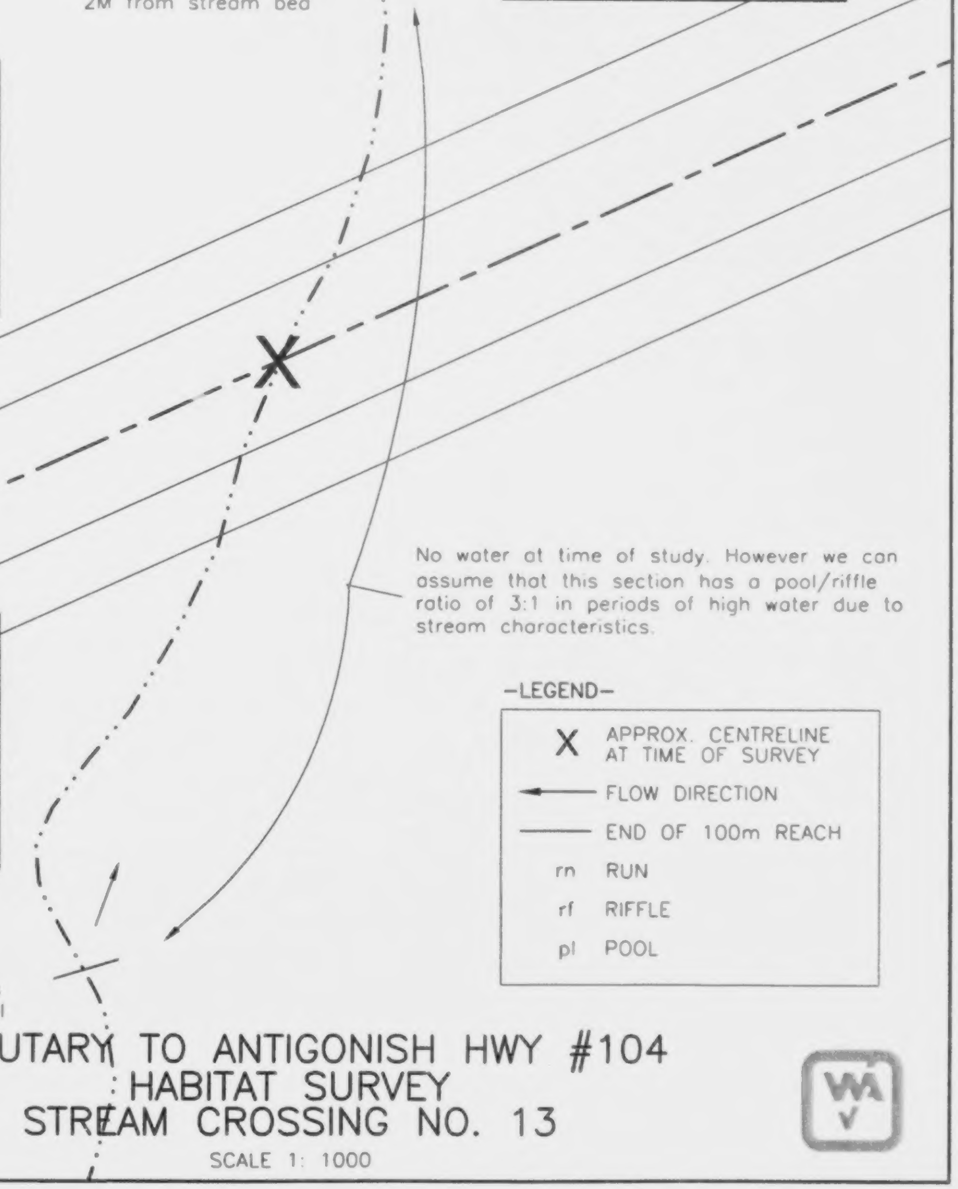
PROFILE AT CENTERLINE

Downstream



Centreline

Upstream



No water at time of study. However we can assume that this section has a pool/riffle ratio of 3:1 in periods of high water due to stream characteristics.

-LEGEND-

X	APPROX. CENTRELINE AT TIME OF SURVEY
←	FLOW DIRECTION
—	END OF 100m REACH
rn	RUN
rf	RIFFLE
pl	POOL

TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 13

SCALE 1: 1000

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Table D31 Unnamed Stream (Stream Crossing No.14)
Fish Habitat Summary

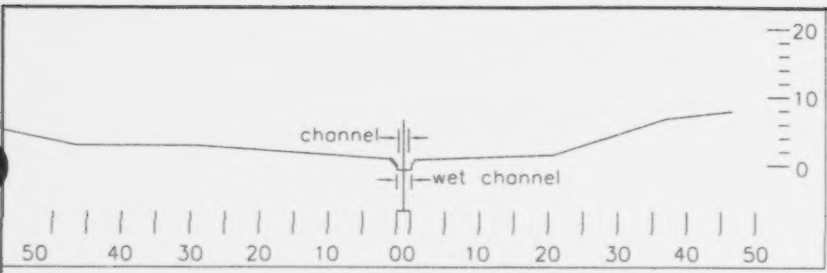
Aquatic Habitat Evaluation at ROW (10 + 850)	
Physical Units	Agricultural drainage ditch
Substrate	Silt 100%
Embeddedness	>50%
Mean Depth (cm)	Dry
Dimensions (m)	1.5m
Bank Stability	50-75%
Overhead Cover	none
Bank Cover	Cattails, grasses (10%
Instream Cover	none
Instream Cover	Grasses and sedges (75-100%)
Physical Observations and Habitat Type (not available due to absence of water)	
Conductivity (FS/cm)	N/A
Flow (m^3/s)	N/A
Water Colour	N/A
pH	N/A
Temperature (°C)	N/A
Fish and Fish Habitat	Type 5 for salmonid habitat.

Table D32 Unnamed Stream (Stream Crossing No.14)
Erosion Sensitivity Level

Bank	Particle Size Class and % Composition	Relative Soil Erodibility	Slope (50 m back), %	Slope Class	Overall Sensitivity
Left	Dark reddish brown silty sand, with root hairs	High	0%-47%	Very high	High-very high
Right	Dark reddish brown silty clay sand, with root hairs	Moderate	2%-55%	Very high	high

*Relative erodibility based on particle size class/texture of samples collected 10cm deep 5m from stream bank.

Slope class: negligible (0-5%), low (6-15%), moderate (16-30%), high (31-45%), very high (46-60%) extreme (>60%)



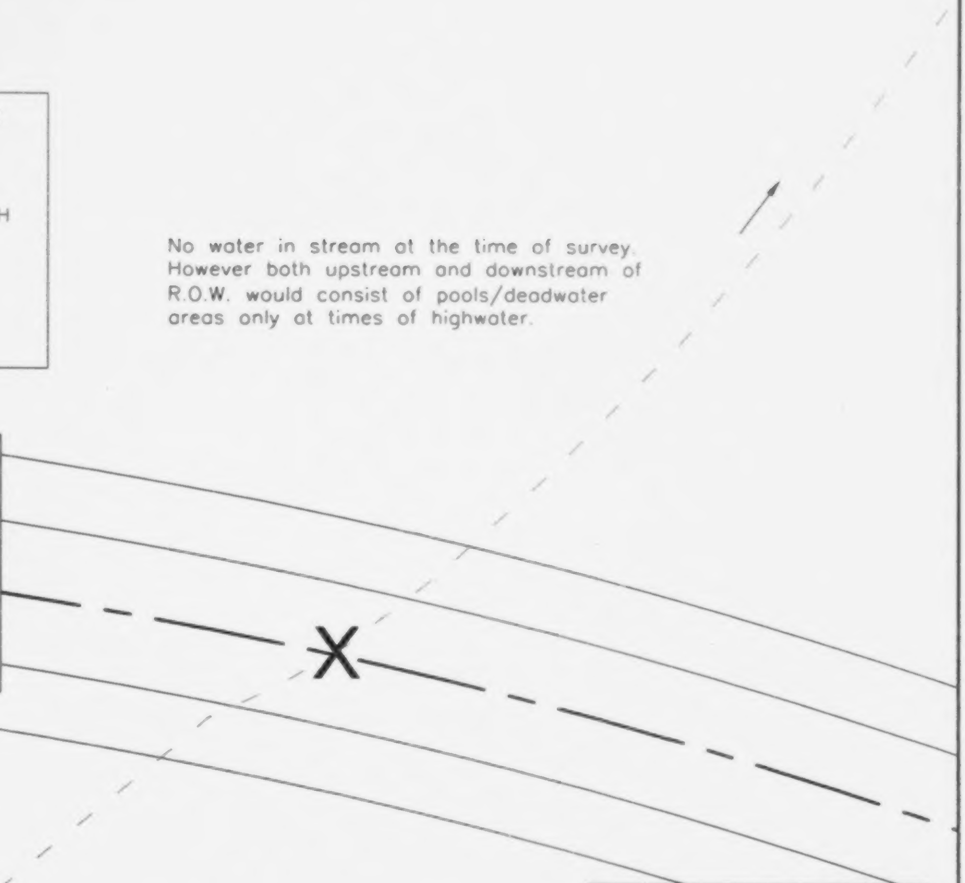
PROFILE AT CENTERLINE

Downstream

-LEGEND-

X	APPROX. CENTRELINE AT TIME OF SURVEY
←	FLOW DIRECTION
—	END OF 100m REACH
rn	RUN
rf	RIFFLE
pl	POOL

No water in stream at the time of survey. However both upstream and downstream of R.O.W. would consist of pools/deadwater areas only at times of highwater.



Centreline

Upstream

TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 14

SCALE 1: 1000

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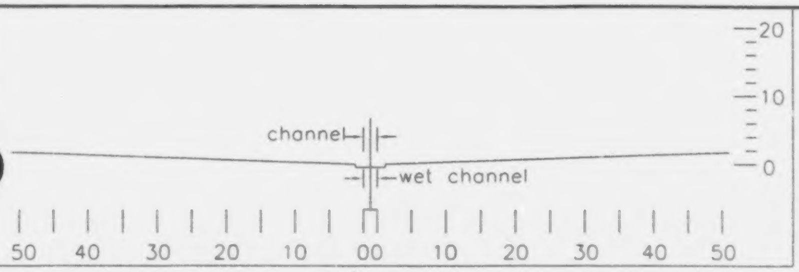
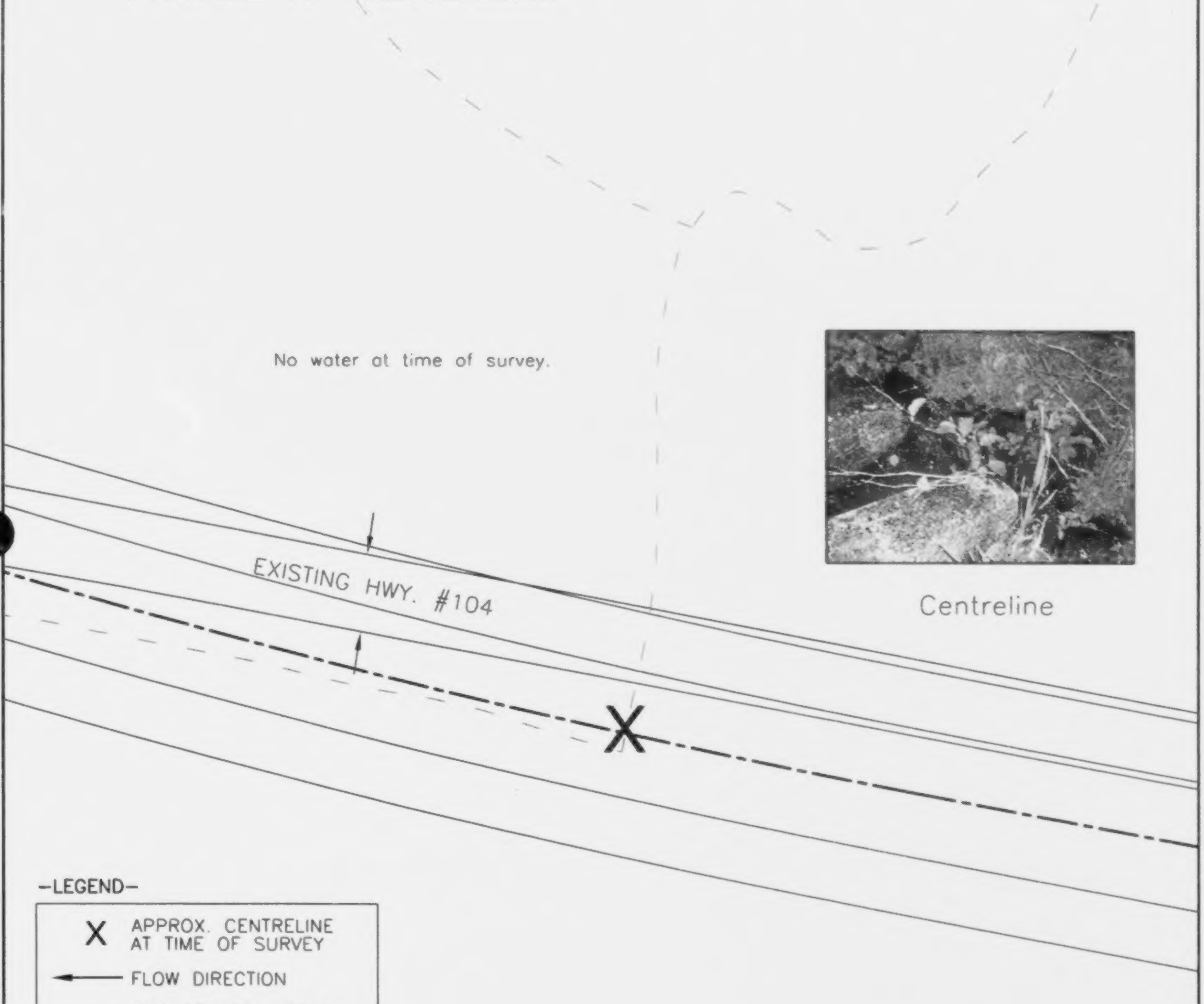
Table D33 Unnamed Stream (Stream Crossing No.15)
Fish Habitat Summary

Aquatic Habitat Evaluation at ROW (14 + 600)	
Physical Units	Overgrown, intermittent ditch stream, runs parallel to existing highway
Substrate	Silt 100%
Embeddedness	>50%
Mean Depth (cm)	3cm
Dimensions (m)	1.5m
Bank Stability	50-75%
Overhead Cover	none
Bank Cover	Cattails (15%)
Instream Cover	none
Physical Observations and Habitat Type (not available due to absence of flow)	
Conductivity (FS/cm)	450
Flow (m^3/s)	N/A due to low waterconditions at tiem of survey
Water Colour	Colourless, with oily sheen on surface
pH	7.3
Temperature (°C)	16
Fish and Fish Habitat	Type 5 for salmonid habitat.

Note: Erosion sensitivity levels were not acquired for crossing 15 as this stretch of the old and new alignment are in the same location; therefore, the stream banks at ROW are under the exiting highway, and soil could not be sampled.



PROFILE AT CENTERLINE



-LEGEND-

X	APPROX. CENTRELINE AT TIME OF SURVEY
←	FLOW DIRECTION
—	END OF 100m REACH
rn	RUN
rf	RIFFLE
pl	POOL

TRIBUTARY TO ANTIGONISH HWY #104
HABITAT SURVEY
STREAM CROSSING NO. 15

SCALE 1: 1000

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Table D34 Fish Species Caught, Stream Crossings Proposed Highway 104 Antigonish, June 24, 2002

Stream Crossing	Fish Species	Total Length (cm)	Fork Length (cm)	Notes
No. 6 4+150 m	1. three-spine stickleback			
	2. three-spine stickleback			
	3. three-spine stickleback			
	4. three-spine stickleback			
	1. nine-spine stickleback			
West River No. 8 5+700 m	1. Atlantic salmon (*Salmo salar)*	13.0	12.5	- Many other small salmon were observed
	2. Atlantic salmon	10.1	9.3	
	3. Atlantic salmon	11.0	10.2	
	4. Atlantic salmon	9.5	8.8	
	5. Atlantic salmon	8.9	8.1	
	6. Atlantic salmon	13.0	11.9	
	7. Atlantic salmon	11.0	10.2	
	8. Atlantic salmon	10.3	9.5	
	9. Atlantic salmon	9.7	9.1	
	10. Atlantic salmon	9.2	8.5	
	11. Atlantic salmon	3.6	3.4	
	1. white sucker (*Catostomus commersoni)*			- All non-salmonids were not measured due to small size (all less than 10.0 cm) - White sucker were abundant in a still-water adjacent to the crossing that is connected to the West River.
	2. white sucker			
	3. white sucker			
	4. white sucker			
	5. white sucker			
	1. banded killifish (*Fundulus diaphanus)*			- Banded killifish were abundant in a still-water adjacent to the crossing that is connected to the West River.
	2. banded killifish			
	3. banded killifish			
	4. banded killifish			
	1. creek chub (*Semotilus atromaculatus)*			- Creek chub were abundant in a still-water adjacent to the crossing that is connected to the West River.
	2. creek chub			
	3. creek chub			
	4. creek chub			
	5. creek chub			
	6. creek chub			
	1. Northern redbelly dace (*Chrosomus eos)*			
	2. Northern redbelly dace			
	3. Northern redbelly dace			
	4. Northern redbelly dace			
	1. three-spine stickleback (*Gasterosteus aculeatus)*			
	2. three-spine stickleback			
	3. three-spine stickleback			
	1. nine-spine stickleback (*Pungitius pungitius)*			

Table D34 Fish Species Caught, Stream Crossings Proposed Highway 104 Antigonish, June 24, 2002

Stream Crossing	Fish Species	Total Length (cm)	Fork Length (cm)	Notes
No. 11 8+150 m	1. creek chub 2. creek chub 3. creek chub 4. creek chub 5. creek chub 6. creek chub 7. creek chub 8. creek chub 9. creek chub 10. creek chub			- Many small creek chub were caught and observed
	1. Northern redbelly dace 2. Northern redbelly dace 3. Northern redbelly dace 4. Northern redbelly dace 5. Northern redbelly dace 6. Northern redbelly dace			
	1. nine-spine stickleback			
	1. three-spine stickleback			

Prepared For:
JWEL

Date Generated
11-Jul-2002
Spreadsheet File Name
0209056H.XLS

Client ID:	5+700	6+950
Project ID:	16949-1	16949-1
PSC Analytical ID:	02-H034261	02-H034262
Matrix:	Water	Water
Duplicate of:		
Date Sampled:		
Client Description:		

	Parameters	Method	EQL	Units	5+700	6+950
PASC-H-:04823	Total Water Digest		-		20020703-A	20020703-A
PASC-H-:50920	Inorganic Comment	Comment		Text	Orthophosphorous; EQL = 0.02 due to elevated method blank.	Orthophosphorous; EQL = 0.02 due to elevated method blank.
PASC-H-RCAp:01010	Sodium	ICP-OES	0.1	mg/L	64.6	6
PASC-H-RCAp:01020	Potassium	ICP-OES	0.1	mg/L	0.8	2
PASC-H-RCAp:01030	Calcium	ICP-OES	0.1	mg/L	23.4	6.4
PASC-H-RCAp:01050	Magnesium	ICP-OES	0.1	mg/L	1.9	2.4
PASC-H-RCAp:01060	Alkalinity (as CaCO3)	COBAS	5	mg/L	16	21
PASC-H-RCAp:01070	Sulfate	COBAS	2	mg/L	50	9
PASC-H-RCAp:01080	Chloride	COBAS	1	mg/L	95	5
PASC-H-RCAp:01090	Reactive Silica (as SiO2)	COBAS	0.5	mg/L	3.2	3.6
PASC-H-RCAp:01100	Ortho Phosphate (as P)	COBAS	0.01	mg/L	< 0.02	< 0.02
PASC-H-RCAp:01105	Nitrite	COBAS	0.01	mg/L	< 0.01	< 0.01
PASC-H-RCAp:01110	Nitrate + Nitrite (as N)	COBAS	0.05	mg/L	< 0.05	0.21
PASC-H-RCAp:01115	Nitrate (as N)	COBAS	0.05	mg/L	< 0.05	0.21
PASC-H-RCAp:01120	Ammonia (as N)	COBAS	0.05	mg/L	< 0.05	< 0.05
PASC-H-RCAp:01170	Color	COBAS	5	TCU	7	22
PASC-H-RCAp:01180	Turbidity	NEPH.	0.1	NTU	0.5	32
PASC-H-RCAp:01190	Conductance (RCAp)	Electrode	1	uS/cm	502	73
PASC-H-RCAp:01200	pH	Electrode	-	Units	7.3	6.9
PASC-H-RCAp:01220	Hardness (as CaCO3)	Calculated	0.1	mg/L	66.3	25.9
PASC-H-RCAp:01230	Bicarbonate (as CaCO3)	Calculated	1	mg/L	16	21
PASC-H-RCAp:01240	Carbonate (as CaCO3)	Calculated	1	mg/L	< 1	< 1
PASC-H-RCAp:01250	TDS (Calculated)	Calculated	1	mg/L	249	48
PASC-H-RCAp:01270	Cation Sum	Calculated	0.1	meq/L	4.16	0.83
PASC-H-RCAp:01280	Anion Sum	Calculated	0.1	meq/L	4.04	0.76
PASC-H-RCAp:01290	Ion Balance	Calculated	-	%	1.41	4.36
PASC-H-RCAp:01311	Langlier Index @ 4C	Calculated	-		-1.99	-2.80
PASC-H-RCAp:01312	Langlier Index @ 20C	Calculated	-		-1.59	-2.40
PASC-H-RCAp:01313	Saturation pH @ 4C	Calculated	-	Units	9.29	9.7
PASC-H-RCAp:01314	Saturation pH @ 20C	Calculated	-	Units	8.89	9.3
PASC-H-RCAp:02010	Aluminum	ICP-MS	10	ug/L	20	1800
PASC-H-RCAp:02020	Antimony	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02030	Arsenic	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02040	Barium	ICP-MS	5	ug/L	30	38
PASC-H-RCAp:02050	Beryllium	ICP-MS	5	ug/L	< 5	< 5
PASC-H-RCAp:02060	Bismuth	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02070	Boron	ICP-MS	5	ug/L	14	12
PASC-H-RCAp:02080	Cadmium	ICP-MS	0.3	ug/L	< 0.3	< 0.3
PASC-H-RCAp:02090	Chromium	ICP-MS	2	ug/L	< 2	2
PASC-H-RCAp:02100	Cobalt	ICP-MS	1	ug/L	< 1	2
PASC-H-RCAp:02110	Copper	ICP-MS	2	ug/L	< 2	5
PASC-H-RCAp:02130	Iron	ICP-MS	20	ug/L	70	1900
PASC-H-RCAp:02140	Lead	ICP-MS	0.5	ug/L	< 0.5	2.2
PASC-H-RCAp:02150	Manganese	ICP-MS	2	ug/L	8	200
PASC-H-RCAp:02160	Molybdenum	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02170	Nickel	ICP-MS	2	ug/L	< 2	4
PASC-H-RCAp:02180	Selenium	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02200	Silver	ICP-MS	0.5	ug/L	< 0.5	< 0.5
PASC-H-RCAp:02220	Strontium	ICP-MS	5	ug/L	240	23
PASC-H-RCAp:02230	Thallium	ICP-MS	0.1	ug/L	< 0.1	< 0.1
PASC-H-RCAp:02240	Tin	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02250	Titanium	ICP-MS	2	ug/L	2	32
PASC-H-RCAp:02260	Uranium	ICP-MS	0.1	ug/L	< 0.1	0.1
PASC-H-RCAp:02270	Vanadium	ICP-MS	2	ug/L	< 2	2
PASC-H-RCAp:02280	Zinc	ICP-MS	2	ug/L	4	26
PASC-H-RCAp:04060	Phosphorus	ICP-OES	0.1	mg/L	0.1	0.2
PASC-H-RCAp:04070	Total Org. Carbon (by UV)	U.V.-ox	0.5	mg/L	1.9	7.6
PASC-H-RCAp:50770	RCAp Comments	Comment		Text		

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Date Generated
11-Jul-2002
Spreadsheet File Name
0209056H.XLS

	Parameters	1+500 16949-1 02-H034263 Water	14+600 16949-1 02-H034264 Water	8+150 16949-1 02-H034265 Water
PASC-H-:04823	Total Water Digest	20020703-A	20020703-A	20020703-B
PASC-H-:50920	Inorganic Comment	Orthophosphorous; EQL = 0.02 due to elevated method blank.	Orthophosphorous; EQL = 0.02 due to elevated method blank.	Orthophosphorous; EQL = 0.02 due to elevated method blank.
PASC-H-RCAp:01010	Sodium	147	86.2	14.2
PASC-H-RCAp:01020	Potassium	1.3	0.7	1.6
PASC-H-RCAp:01030	Calcium	63.9	22.3	27.6
PASC-H-RCAp:01050	Magnesium	6.2	5.3	4.5
PASC-H-RCAp:01060	Alkalinity (as CaCO3)	170	57	49
PASC-H-RCAp:01070	Sulfate	25	8	48
PASC-H-RCAp:01080	Chloride	210	150	10
PASC-H-RCAp:01090	Reactive Silica (as SiO2)	4.1	2.8	0.5
PASC-H-RCAp:01100	Ortho Phosphate (as P)	< 0.02	< 0.02	< 0.02
PASC-H-RCAp:01105	Nitrite	< 0.01	< 0.01	< 0.01
PASC-H-RCAp:01110	Nitrate + Nitrite (as N)	0.07	0.07	0.06
PASC-H-RCAp:01115	Nitrate (as N)	0.07	0.07	0.06
PASC-H-RCAp:01120	Ammonia (as N)	0.05	< 0.05	< 0.05
PASC-H-RCAp:01170	Color	30	27	39
PASC-H-RCAp:01180	Turbidity	3	1.5	1.5
PASC-H-RCAp:01190	Conductance (RCAp)	1140	628	245
PASC-H-RCAp:01200	pH	7.8	6.5	7.4
PASC-H-RCAp:01220	Hardness (as CaCO3)	185	77.5	87.4
PASC-H-RCAp:01230	Bicarbonate (as CaCO3)	169	57	49
PASC-H-RCAp:01240	Carbonate (as CaCO3)	1	< 1	< 1
PASC-H-RCAp:01250	TDS (Calculated)	560	310	136
PASC-H-RCAp:01270	Cation Sum	10.1	5.32	2.41
PASC-H-RCAp:01280	Anion Sum	9.85	5.54	2.26
PASC-H-RCAp:01290	Ion Balance	1.42	2.03	3.11
PASC-H-RCAp:01311	Langlier Index @ 4C	-0.06	-2.27	-1.32
PASC-H-RCAp:01312	Langlier Index @ 20C	0.34	-1.87	-0.92
PASC-H-RCAp:01313	Saturation pH @ 4C	7.86	8.77	8.72
PASC-H-RCAp:01314	Saturation pH @ 20C	7.46	8.37	8.32
PASC-H-RCAp:02010	Aluminum	110	90	40
PASC-H-RCAp:02020	Antimony	< 2	< 2	< 2
PASC-H-RCAp:02030	Arsenic	< 2	< 2	< 2
PASC-H-RCAp:02040	Barium	180	190	20
PASC-H-RCAp:02050	Beryllium	< 5	< 5	< 5
PASC-H-RCAp:02060	Bismuth	< 2	< 2	< 2
PASC-H-RCAp:02070	Boron	17	7	20
PASC-H-RCAp:02080	Cadmium	< 0.3	< 0.3	< 0.3
PASC-H-RCAp:02090	Chromium	< 2	< 2	< 2
PASC-H-RCAp:02100	Cobalt	< 1	6	< 1
PASC-H-RCAp:02110	Copper	5	2	2
PASC-H-RCAp:02130	Iron	310	1600	130
PASC-H-RCAp:02140	Lead	< 0.5	0.6	< 0.5
PASC-H-RCAp:02150	Manganese	260	3600	42
PASC-H-RCAp:02160	Molybdenum	< 2	< 2	< 2
PASC-H-RCAp:02170	Nickel	< 2	3	< 2
PASC-H-RCAp:02180	Selenium	< 2	< 2	< 2
PASC-H-RCAp:02200	Silver	< 0.5	< 0.5	< 0.5
PASC-H-RCAp:02220	Strontium	93	110	210
PASC-H-RCAp:02230	Thallium	< 0.1	< 0.1	< 0.1
PASC-H-RCAp:02240	Tin	< 2	< 2	< 2
PASC-H-RCAp:02250	Titanium	3	< 2	4
PASC-H-RCAp:02260	Uranium	0.9	< 0.1	0.1
PASC-H-RCAp:02270	Vanadium	< 2	< 2	< 2
PASC-H-RCAp:02280	Zinc	5	10	3
PASC-H-RCAp:04060	Phosphorus	0.1	0.1	0.1
PASC-H-RCAp:04070	Total Org. Carbon (by UV)	5.8	4.5	12.9
PASC-H-RCAp:50770	RCAp Comments			

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Date Generated
11-Jul-2002
Spreadsheet File Name
0209056H.XLS

	Parameters	0+800 16949-1 02-H034266 Water	2+600 16949-1 02-H034267 Water	5+500 16949-1 02-H034268 Water
PASC-H-:04823	Total Water Digest	20020703-B	20020703-B	20020703-B
PASC-H-:50920	Inorganic Comment	Orthophosphorous; EQL = 0.02 due to elevated method blank.	Orthophosphorous; EQL = 0.02 due to elevated method blank.	Orthophosphorous; EQL = 0.02 due to elevated method blank.
PASC-H-RCAp:01010	Sodium	23.3	57.2	36.5
PASC-H-RCAp:01020	Potassium	0.5	1.2	1
PASC-H-RCAp:01030	Calcium	9.6	26.7	18.2
PASC-H-RCAp:01050	Magnesium	1.4	3.5	4.6
PASC-H-RCAp:01060	Alkalinity (as CaCO3)	17	61	35
PASC-H-RCAp:01070	Sulfate	19	10	9
PASC-H-RCAp:01080	Chloride	35	95	72
PASC-H-RCAp:01090	Reactive Silica (as SiO2)	< 0.5	3.4	2.2
PASC-H-RCAp:01100	Ortho Phosphate (as P)	< 0.02	< 0.02	< 0.02
PASC-H-RCAp:01105	Nitrite	< 0.01	< 0.01	< 0.01
PASC-H-RCAp:01110	Nitrate + Nitrite (as N)	0.06	0.09	0.08
PASC-H-RCAp:01115	Nitrate (as N)	0.06	0.09	0.08
PASC-H-RCAp:01120	Ammonia (as N)	< 0.05	< 0.05	< 0.05
PASC-H-RCAp:01170	Color	82	36	43
PASC-H-RCAp:01180	Turbidity	8.8	36.2	2.6
PASC-H-RCAp:01190	Conductance (RCAp)	174	443	337
PASC-H-RCAp:01200	pH	6.5	7.4	7.1
PASC-H-RCAp:01220	Hardness (as CaCO3)	29.7	81.1	64.4
PASC-H-RCAp:01230	Bicarbonate (as CaCO3)	17	61	35
PASC-H-RCAp:01240	Carbonate (as CaCO3)	< 1	< 1	< 1
PASC-H-RCAp:01250	TDS (Calculated)	99	234	165
PASC-H-RCAp:01270	Cation Sum	1.62	4.14	2.9
PASC-H-RCAp:01280	Anion Sum	1.73	4.11	2.92
PASC-H-RCAp:01290	Ion Balance	3.04	0.36	0.34
PASC-H-RCAp:01311	Langlier Index @ 4C	-3.13	-1.25	-1.95
PASC-H-RCAp:01312	Langlier Index @ 20C	-2.73	-0.85	-1.55
PASC-H-RCAp:01313	Saturation pH @ 4C	9.63	8.65	9.05
PASC-H-RCAp:01314	Saturation pH @ 20C	9.23	8.25	8.65
PASC-H-RCAp:02010	Aluminum	200	1300	150
PASC-H-RCAp:02020	Antimony	< 2	< 2	< 2
PASC-H-RCAp:02030	Arsenic	< 2	< 2	< 2
PASC-H-RCAp:02040	Barium	23	67	37
PASC-H-RCAp:02050	Beryllium	< 5	< 5	< 5
PASC-H-RCAp:02060	Bismuth	< 2	< 2	< 2
PASC-H-RCAp:02070	Boron	7	12	8
PASC-H-RCAp:02080	Cadmium	< 0.3	< 0.3	< 0.3
PASC-H-RCAp:02090	Chromium	< 2	2	< 2
PASC-H-RCAp:02100	Cobalt	1	1	1
PASC-H-RCAp:02110	Copper	3	3	3
PASC-H-RCAp:02130	Iron	1700	1500	730
PASC-H-RCAp:02140	Lead	1.3	1.9	< 0.5
PASC-H-RCAp:02150	Manganese	170	230	310
PASC-H-RCAp:02160	Molybdenum	< 2	< 2	< 2
PASC-H-RCAp:02170	Nickel	< 2	3	< 2
PASC-H-RCAp:02180	Selenium	< 2	< 2	< 2
PASC-H-RCAp:02200	Silver	< 0.5	< 0.5	< 0.5
PASC-H-RCAp:02220	Strontium	35	64	78
PASC-H-RCAp:02230	Thallium	< 0.1	< 0.1	< 0.1
PASC-H-RCAp:02240	Tin	< 2	< 2	< 2
PASC-H-RCAp:02250	Titanium	4	28	5
PASC-H-RCAp:02260	Uranium	< 0.1	0.2	< 0.1
PASC-H-RCAp:02270	Vanadium	< 2	2	< 2
PASC-H-RCAp:02280	Zinc	10	20	8
PASC-H-RCAp:04060	Phosphorus	0.2	0.2	0.1
PASC-H-RCAp:04070	Total Org. Carbon (by UV)	15.5	8.7	9.8
PASC-H-RCAp:50770	RCAp Comments			

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Date Generated
11-Jul-2002
Spreadsheet File Name
0209056H.XLS

	Parameters	6+750 16949-1 02-H034269 Water	4+150 16949-1 02-H034270 Water	1+400 16949-1 02-H034271 Water
PASC-H-:04823	Total Water Digest	20020703-B	20020703-B	20020703-B
PASC-H-:50920	Inorganic Comment	Orthophosphorous; EQL = 0.02 due to elevated method blank.	Orthophosphorous; EQL = 0.02 due to elevated method blank.	Orthophosphorous; EQL = 0.02 due to elevated method blank.
PASC-H-RCAp:01010	Sodium	33.5	70.1	318
PASC-H-RCAp:01020	Potassium	2.2	2.7	1.2
PASC-H-RCAp:01030	Calcium	32.7	64.1	55
PASC-H-RCAp:01050	Magnesium	6.1	9	5.4
PASC-H-RCAp:01060	Alkalinity (as CaCO3)	69	120	140
PASC-H-RCAp:01070	Sulfate	21	50	71
PASC-H-RCAp:01080	Chloride	74	120	460
PASC-H-RCAp:01090	Reactive Silica (as SiO2)	4.3	4.1	2.7
PASC-H-RCAp:01100	Ortho Phosphate (as P)	< 0.02	< 0.02	< 0.02
PASC-H-RCAp:01105	Nitrite	< 0.01	0.01	< 0.01
PASC-H-RCAp:01110	Nitrate + Nitrite (as N)	0.09	0.12	0.09
PASC-H-RCAp:01115	Nitrate (as N)	0.09	0.11	0.09
PASC-H-RCAp:01120	Ammonia (as N)	0.11	0.05	< 0.05
PASC-H-RCAp:01170	Color	23	130	45
PASC-H-RCAp:01180	Turbidity	18.9	55.6	2.4
PASC-H-RCAp:01190	Conductance (RCAp)	400	780	2030
PASC-H-RCAp:01200	pH	7.3	7.8	7.9
PASC-H-RCAp:01220	Hardness (as CaCO3)	107	197	160
PASC-H-RCAp:01230	Bicarbonate (as CaCO3)	69	119	139
PASC-H-RCAp:01240	Carbonate (as CaCO3)	< 1	< 1	1
PASC-H-RCAp:01250	TDS (Calculated)	216	393	998
PASC-H-RCAp:01270	Cation Sum	3.66	7.06	17.1
PASC-H-RCAp:01280	Anion Sum	3.91	6.83	17.3
PASC-H-RCAp:01290	Ion Balance	3.37	1.65	0.58
PASC-H-RCAp:01311	Langlier Index @ 4C	-1.21	-0.20	-0.14
PASC-H-RCAp:01312	Langlier Index @ 20C	-0.81	0.2	0.26
PASC-H-RCAp:01313	Saturation pH @ 4C	8.51	8	8.04
PASC-H-RCAp:01314	Saturation pH @ 20C	8.11	7.6	7.64
PASC-H-RCAp:02010	Aluminum	590	2100	90
PASC-H-RCAp:02020	Antimony	< 2	< 2	< 2
PASC-H-RCAp:02030	Arsenic	< 2	2	< 2
PASC-H-RCAp:02040	Barium	110	180	150
PASC-H-RCAp:02050	Beryllium	< 5	< 5	< 5
PASC-H-RCAp:02060	Bismuth	< 2	< 2	< 2
PASC-H-RCAp:02070	Boron	11	29	13
PASC-H-RCAp:02080	Cadmium	< 0.3	< 0.3	< 0.3
PASC-H-RCAp:02090	Chromium	< 2	5	< 2
PASC-H-RCAp:02100	Cobalt	1	3	< 1
PASC-H-RCAp:02110	Copper	5	11	10
PASC-H-RCAp:02130	Iron	770	4700	90
PASC-H-RCAp:02140	Lead	1.1	7.6	0.7
PASC-H-RCAp:02150	Manganese	72	1800	12
PASC-H-RCAp:02160	Molybdenum	< 2	< 2	< 2
PASC-H-RCAp:02170	Nickel	2	5	< 2
PASC-H-RCAp:02180	Selenium	< 2	< 2	< 2
PASC-H-RCAp:02200	Silver	< 0.5	< 0.5	< 0.5
PASC-H-RCAp:02220	Strontium	70	310	99
PASC-H-RCAp:02230	Thallium	< 0.1	< 0.1	< 0.1
PASC-H-RCAp:02240	Tin	< 2	< 2	< 2
PASC-H-RCAp:02250	Titanium	13	53	3
PASC-H-RCAp:02260	Uranium	0.1	0.2	0.4
PASC-H-RCAp:02270	Vanadium	< 2	4	< 2
PASC-H-RCAp:02280	Zinc	18	69	6
PASC-H-RCAp:04060	Phosphorus	0.1	0.2	0.1
PASC-H-RCAp:04070	Total Org. Carbon (by UV)	5.5	19.5	9.8
PASC-H-RCAp:50770	RCAp Comments			

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Date Generated
11-Jul-2002
Spreadsheet File Name
0209056H.XLS

	Parameters	No # 5 DUP 16949-1 02-H034272 Water 02-H034271	0+100 16949-1 02-H034273 Water
PASC-H-:04823	Total Water Digest	20020703-B	20020703-B
PASC-H-:50920	Inorganic Comment	Orthophosphorous; EQL = 0.02 due to elevated method blank.	Orthophosphorous; EQL = 0.02 due to elevated method blank.
PASC-H-RCAp:01010	Sodium	320	3.6
PASC-H-RCAp:01020	Potassium	1.4	0.6
PASC-H-RCAp:01030	Calcium	57.9	3
PASC-H-RCAp:01050	Magnesium	5.5	1
PASC-H-RCAp:01060	Alkalinity (as CaCO3)	140	10
PASC-H-RCAp:01070	Sulfate	89	12
PASC-H-RCAp:01080	Chloride	460	4
PASC-H-RCAp:01090	Reactive Silica (as SiO2)	2.7	3
PASC-H-RCAp:01100	Ortho Phosphate (as P)	0.01	0.02
PASC-H-RCAp:01105	Nitrite	< 0.01	0.02
PASC-H-RCAp:01110	Nitrate + Nitrite (as N)	0.09	0.11
PASC-H-RCAp:01115	Nitrate (as N)	0.09	0.09
PASC-H-RCAp:01120	Ammonia (as N)	< 0.05	< 0.05
PASC-H-RCAp:01170	Color	45	49
PASC-H-RCAp:01180	Turbidity	2.1	14.5
PASC-H-RCAp:01190	Conductance (RCAp)	2030	41
PASC-H-RCAp:01200	pH	7.8	6.7
PASC-H-RCAp:01220	Hardness (as CaCO3)	167	11.6
PASC-H-RCAp:01230	Bicarbonate (as CaCO3)	139	10
PASC-H-RCAp:01240	Carbonate (as CaCO3)	< 1	< 1
PASC-H-RCAp:01250	TDS (Calculated)	1020	34
PASC-H-RCAp:01270	Cation Sum	17.3	0.41
PASC-H-RCAp:01280	Anion Sum	17.6	0.57
PASC-H-RCAp:01290	Ion Balance	0.94	16.6
PASC-H-RCAp:01311	Langlier Index @ 4C	-0.22	-3.64
PASC-H-RCAp:01312	Langlier Index @ 20C	0.18	-3.24
PASC-H-RCAp:01313	Saturation pH @ 4C	8.02	10.3
PASC-H-RCAp:01314	Saturation pH @ 20C	7.62	9.94
PASC-H-RCAp:02010	Aluminum	90	730
PASC-H-RCAp:02020	Antimony	< 2	< 2
PASC-H-RCAp:02030	Arsenic	< 2	< 2
PASC-H-RCAp:02040	Barium	150	20
PASC-H-RCAp:02050	Beryllium	< 5	< 5
PASC-H-RCAp:02060	Bismuth	< 2	< 2
PASC-H-RCAp:02070	Boron	14	7
PASC-H-RCAp:02080	Cadmium	< 0.3	< 0.3
PASC-H-RCAp:02090	Chromium	< 2	< 2
PASC-H-RCAp:02100	Cobalt	< 1	< 1
PASC-H-RCAp:02110	Copper	11	2
PASC-H-RCAp:02130	Iron	100	400
PASC-H-RCAp:02140	Lead	0.7	< 0.5
PASC-H-RCAp:02150	Manganese	12	38
PASC-H-RCAp:02160	Molybdenum	< 2	< 2
PASC-H-RCAp:02170	Nickel	< 2	< 2
PASC-H-RCAp:02180	Selenium	< 2	< 2
PASC-H-RCAp:02200	Silver	< 0.5	< 0.5
PASC-H-RCAp:02220	Strontium	100	11
PASC-H-RCAp:02230	Thallium	< 0.1	< 0.1
PASC-H-RCAp:02240	Tin	< 2	< 2
PASC-H-RCAp:02250	Titanium	4	23
PASC-H-RCAp:02260	Uranium	0.4	0.1
PASC-H-RCAp:02270	Vanadium	< 2	< 2
PASC-H-RCAp:02280	Zinc	6	12
PASC-H-RCAp:04060	Phosphorus	0.1	< 0.1
PASC-H-RCAp:04070	Total Org. Carbon (by UV)	9.3	4.4
PASC-H-RCAp:50770	RCAp Comments		EQL for K raised to <0.2 due to elevated blanks.

Prepared For:
JWEL

Date Generated
9-Nov-2002
Spreadsheet File Name
0216601H.XLS

Client ID:	1	2
Project ID:	16949	16949
PSC Analytical ID:	02-H067562	02-H067563
Matrix:	Water	Water
Duplicate of:		
Date Sampled:	31-Oct-02	31-Oct-02
Client Description:		

	Parameters	Method	EQL	Units		
PASC-H-:01316	Total Suspended Solids	Grav.	0.5	mg/L	< 2	< 2
PASC-H-:04823	Total Water Digest		-		20021101-A	20021101-A
PASC-H-:50920	Inorganic Comment	Comment		Text		
PASC-H-RCAp:01010	Sodium	ICP-OES	0.1	mg/L	4.4	15
PASC-H-RCAp:01020	Potassium	ICP-OES	0.1	mg/L	0.6	1.2
PASC-H-RCAp:01030	Calcium	ICP-OES	0.1	mg/L	2.2	7.8
PASC-H-RCAp:01050	Magnesium	ICP-OES	0.1	mg/L	0.9	1.5
PASC-H-RCAp:01060	Alkalinity (as CaCO3)	COBAS	5	mg/L	< 5	14
PASC-H-RCAp:01070	Sulfate	COBAS	2	mg/L	13	21
PASC-H-RCAp:01080	Chloride	COBAS	1	mg/L	8	17
PASC-H-RCAp:01090	Reactive Silica (as SiO2)	COBAS	0.5	mg/L	3.4	3.4
PASC-H-RCAp:01100	Ortho Phosphate (as P)	COBAS	0.01	mg/L	< 0.01	0.02
PASC-H-RCAp:01105	Nitrite	COBAS	0.01	mg/L	< 0.01	< 0.01
PASC-H-RCAp:01110	Nitrate + Nitrite (as N)	COBAS	0.05	mg/L	< 0.05	< 0.05
PASC-H-RCAp:01115	Nitrate (as N)	COBAS	0.05	mg/L	< 0.05	< 0.05
PASC-H-RCAp:01120	Ammonia (as N)	COBAS	0.05	mg/L	< 0.05	< 0.05
PASC-H-RCAp:01170	Color	COBAS	5	TCU	43	120
PASC-H-RCAp:01180	Turbidity	NEPH.	0.1	NTU	0.9	2.1
PASC-H-RCAp:01190	Conductance (RCAp)	Electrode	1	uS/cm	50	123
PASC-H-RCAp:01200	pH	Electrode	-	Units	6	6.6
PASC-H-RCAp:01220	Hardness (as CaCO3)	Calculated	0.1	mg/L	9.2	25.7
PASC-H-RCAp:01230	Bicarbonate (as CaCO3)	Calculated	1	mg/L	< 5	14
PASC-H-RCAp:01240	Carbonate (as CaCO3)	Calculated	1	mg/L	< 5	< 1
PASC-H-RCAp:01250	TDS (Calculated)	Calculated	1	mg/L	36	76
PASC-H-RCAp:01270	Cation Sum	Calculated	0.1	meq/L	0.4	1.2
PASC-H-RCAp:01280	Anion Sum	Calculated	0.1	meq/L	0.6	1.2
PASC-H-RCAp:01290	Ion Balance	Calculated	-	%	20.5	0
PASC-H-RCAp:01311	Langlier Index @ 4C	Calculated	-		-4.78	-3.19
PASC-H-RCAp:01312	Langlier Index @ 20C	Calculated	-		-4.38	-2.79
PASC-H-RCAp:01313	Saturation pH @ 4C	Calculated	-	Units	10.8	9.79
PASC-H-RCAp:01314	Saturation pH @ 20C	Calculated	-	Units	10.4	9.39
PASC-H-RCAp:02010	Aluminum	ICP-MS	10	ug/L	270	170
PASC-H-RCAp:02020	Antimony	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02030	Arsenic	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02040	Barium	ICP-MS	5	ug/L	19	13
PASC-H-RCAp:02050	Beryllium	ICP-MS	5	ug/L	< 5	< 5
PASC-H-RCAp:02060	Bismuth	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02070	Boron	ICP-MS	5	ug/L	< 5	7
PASC-H-RCAp:02080	Cadmium	ICP-MS	0.3	ug/L	< 0.3	< 0.3
PASC-H-RCAp:02090	Chromium	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02100	Cobalt	ICP-MS	1	ug/L	< 1	< 1
PASC-H-RCAp:02110	Copper	ICP-MS	2	ug/L	2	2
PASC-H-RCAp:02130	Iron	ICP-MS	20	ug/L	150	330
PASC-H-RCAp:02140	Lead	ICP-MS	0.5	ug/L	< 0.5	< 0.5
PASC-H-RCAp:02150	Manganese	ICP-MS	2	ug/L	20	15
PASC-H-RCAp:02160	Molybdenum	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02170	Nickel	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02180	Selenium	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02200	Silver	ICP-MS	0.5	ug/L	< 0.5	< 0.5
PASC-H-RCAp:02220	Strontium	ICP-MS	5	ug/L	8	31
PASC-H-RCAp:02230	Thallium	ICP-MS	0.1	ug/L	< 0.1	< 0.1
PASC-H-RCAp:02240	Tin	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02250	Titanium	ICP-MS	2	ug/L	2	3
PASC-H-RCAp:02260	Uranium	ICP-MS	0.1	ug/L	< 0.1	< 0.1
PASC-H-RCAp:02270	Vanadium	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02280	Zinc	ICP-MS	2	ug/L	8	4
PASC-H-RCAp:04060	Phosphorus	ICP-OES	0.1	mg/L	< 0.1	< 0.1
PASC-H-RCAp:04070	Total Org. Carbon (by UV)	U.V.-ox	0.5	mg/L	9.6	16.5
PASC-H-RCAp:50770	RCAp Comments	Comment		Text	EQL for K elevated to <0.2 due to elevated blanks and	EQL for K elevated to <0.2 due to elevated blanks and

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Date Generated
9-Nov-2002
Spreadsheet File Name
0216601H.XLS

	Parameters	3 16949 02-H067564 Water 31-Oct-02	4 16949 02-H067565 Water 31-Oct-02	5 16949 02-H067566 Water 31-Oct-02	6 16949 02-H067567 Water 31-Oct-02	7 16949 02-H067568 Water 31-Oct-02
PASC-H-:01316	Total Suspended Solids	< 2	< 2	< 2	< 2	2.5
PASC-H-:04823	Total Water Digest	20021101-A	20021101-A	20021101-B	20021101-B	20021101-B
PASC-H-:50920	Inorganic Comment					
PASC-H-RCAp:01010	Sodium	47.1	29.2	29.5	18.5	6.5
PASC-H-RCAp:01020	Potassium	1.7	0.9	1.2	1.5	0.8
PASC-H-RCAp:01030	Calcium	43.1	33.4	11	29.8	6.1
PASC-H-RCAp:01050	Magnesium	4.4	3.7	1.7	4.5	1.9
PASC-H-RCAp:01060	Alkalinity (as CaCO3)	94	87	33	67	16
PASC-H-RCAp:01070	Sulfate	18	21	15	31	10
PASC-H-RCAp:01080	Chloride	72	33	42	28	12
PASC-H-RCAp:01090	Reactive Silica (as SiO2)	4.3	3.4	3.9	4.5	4
PASC-H-RCAp:01100	Ortho Phosphate (as P)	< 0.01	< 0.01	0.01	< 0.01	0.02
PASC-H-RCAp:01105	Nitrite	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
PASC-H-RCAp:01110	Nitrate + Nitrite (as N)	0.05	< 0.05	0.11	0.06	< 0.05
PASC-H-RCAp:01115	Nitrate (as N)	0.05	< 0.05	0.11	0.06	< 0.05
PASC-H-RCAp:01120	Ammonia (as N)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
PASC-H-RCAp:01170	Color	25	25	84	26	47
PASC-H-RCAp:01180	Turbidity	2.2	3.1	3.2	7	5.8
PASC-H-RCAp:01190	Conductance (RCAp)	503	353	231	317	91
PASC-H-RCAp:01200	pH	7.9	8.1	7.5	7.9	7
PASC-H-RCAp:01220	Hardness (as CaCO3)	126	98.6	34.5	92.9	23.1
PASC-H-RCAp:01230	Bicarbonate (as CaCO3)	93	86	33	66	16
PASC-H-RCAp:01240	Carbonate (as CaCO3)	< 1	1	< 1	< 1	< 1
PASC-H-RCAp:01250	TDS (Calculated)	247	177	125	158	51
PASC-H-RCAp:01270	Cation Sum	4.61	3.27	2.01	2.7	0.77
PASC-H-RCAp:01280	Anion Sum	4.29	3.11	2.16	2.78	0.87
PASC-H-RCAp:01290	Ion Balance	3.6	2.46	3.79	1.36	6.25
PASC-H-RCAp:01311	Langlier Index @ 4C	-0.36	-0.29	-1.78	-0.65	-2.84
PASC-H-RCAp:01312	Langlier Index @ 20C	0.04	0.11	-1.38	-0.25	-2.44
PASC-H-RCAp:01313	Saturation pH @ 4C	8.26	8.39	9.28	8.55	9.84
PASC-H-RCAp:01314	Saturation pH @ 20C	7.86	7.99	8.88	8.15	9.44
PASC-H-RCAp:02010	Aluminum	50	780	210	160	270
PASC-H-RCAp:02020	Antimony	< 2	< 20	< 2	< 2	< 2
PASC-H-RCAp:02030	Arsenic	< 2	< 20	< 2	< 2	< 2
PASC-H-RCAp:02040	Barium	82	580	25	39	16
PASC-H-RCAp:02050	Beryllium	< 5	< 50	< 5	< 5	< 5
PASC-H-RCAp:02060	Bismuth	< 2	< 20	< 2	< 2	< 2
PASC-H-RCAp:02070	Boron	7	93	9	14	< 5
PASC-H-RCAp:02080	Cadmium	< 0.3	< 3	< 0.3	< 0.3	< 0.3
PASC-H-RCAp:02090	Chromium	< 2	< 20	< 2	< 2	< 2
PASC-H-RCAp:02100	Cobalt	< 1	< 10	< 1	< 1	< 1
PASC-H-RCAp:02110	Copper	2	62	3	3	2
PASC-H-RCAp:02130	Iron	90	520	300	220	370
PASC-H-RCAp:02140	Lead	< 0.5	< 5	< 0.5	< 0.5	< 0.5
PASC-H-RCAp:02150	Manganese	10	34	8	90	31
PASC-H-RCAp:02160	Molybdenum	< 2	< 20	< 2	< 2	< 2
PASC-H-RCAp:02170	Nickel	< 2	< 20	< 2	< 2	< 2
PASC-H-RCAp:02180	Selenium	< 2	< 20	< 2	< 2	< 2
PASC-H-RCAp:02200	Silver	< 0.5	< 5	< 0.5	< 0.5	< 0.5
PASC-H-RCAp:02220	Strontium	46	450	25	110	19
PASC-H-RCAp:02230	Thallium	< 0.1	< 1	< 0.1	< 0.1	< 0.1
PASC-H-RCAp:02240	Tin	< 2	< 20	< 2	< 2	< 2
PASC-H-RCAp:02250	Titanium	2	20	4	6	6
PASC-H-RCAp:02260	Uranium	0.5	2.4	0.1	0.1	< 0.1
PASC-H-RCAp:02270	Vanadium	< 2	< 20	< 2	< 2	< 2
PASC-H-RCAp:02280	Zinc	4	120	10	10	10
PASC-H-RCAp:04060	Phosphorus	< 0.1	< 0.1	0.1	< 0.1	< 0.1
PASC-H-RCAp:04070	Total Org. Carbon (by UV)	6.2	6.4	11.8	6.1	10.2
PASC-H-RCAp:50770	RCAp Comments	EQL for K elevated to <0.2 due to elevated blanks and	EQL for K elevated to <0.2 due to elevated blanks and	EQL for K elevated to <0.3 due to elevated blanks and	EQL for K elevated to <0.3 due to elevated blanks and	EQL for K elevated to <0.3 due to elevated blanks and

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

		8	8 DUP	9	10	11
		16949	16949	16949	16949	16949
	Date Generated	02-H067569	02-H067570	02-H067571	02-H067572	02-H067573
	9-Nov-2002	Water	Water	Water	Water	Water
	Spreadsheet File Name		02-H067569			
	0216601H.XLS	31-Oct-02	31-Oct-02	31-Oct-02	31-Oct-02	31-Oct-02
	Parameters					
PASC-H-:01316	Total Suspended Solids	2.5		< 2	3	< 2
PASC-H-:04823	Total Water Digest	20021101-B	20021101-B	20021101-B	20021101-B	20021101-B
PASC-H-:50920	Inorganic Comment			ɜs verified by rep		
PASC-H-RCAp:01010	Sodium	19	19.6	37.5	4.3	8
PASC-H-RCAp:01020	Potassium	1	0.8	1.3	1.4	1.4
PASC-H-RCAp:01030	Calcium	8.9	9.1	36.7	4.1	11.2
PASC-H-RCAp:01050	Magnesium	1.2	1.2	6.3	1.6	2.1
PASC-H-RCAp:01060	Alkalinity (as CaCO3)	11	12	47	11	18
PASC-H-RCAp:01070	Sulfate	22	22	30	13	28
PASC-H-RCAp:01080	Chloride	32	32	73	6	11
PASC-H-RCAp:01090	Reactive Silica (as SiO2)	4.5	4.5	3.5	3.5	3.2
PASC-H-RCAp:01100	Ortho Phosphate (as P)	< 0.01	< 0.01	0.01	0.03	0.02
PASC-H-RCAp:01105	Nitrite	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
PASC-H-RCAp:01110	Nitrate + Nitrite (as N)	0.13	0.13	< 0.05	0.99	< 0.05
PASC-H-RCAp:01115	Nitrate (as N)	0.13	0.13	< 0.05	0.99	< 0.05
PASC-H-RCAp:01120	Ammonia (as N)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
PASC-H-RCAp:01170	Color	27	27	23	42	47
PASC-H-RCAp:01180	Turbidity	2.3	2.4	4.7	7.8	10.9
PASC-H-RCAp:01190	Conductance (RCAp)	187	186	434	65	132
PASC-H-RCAp:01200	pH	7.1	7	7.8	6.9	7.2
PASC-H-RCAp:01220	Hardness (as CaCO3)	27.2	27.7	118	16.8	36.6
PASC-H-RCAp:01230	Bicarbonate (as CaCO3)	11	12	47	11	18
PASC-H-RCAp:01240	Carbonate (as CaCO3)	< 1	< 1	< 1	< 1	< 1
PASC-H-RCAp:01250	TDS (Calculated)	96	97	217	45	76
PASC-H-RCAp:01270	Cation Sum	1.4	1.43	4.02	0.56	1.12
PASC-H-RCAp:01280	Anion Sum	1.59	1.61	3.63	0.73	1.26
PASC-H-RCAp:01290	Ion Balance	6.38	5.91	5.13	12.9	5.77
PASC-H-RCAp:01311	Langlier Index @ 4C	-2.75	-2.80	-0.82	-3.27	-2.33
PASC-H-RCAp:01312	Langlier Index @ 20C	-2.35	-2.40	-0.42	-2.87	-1.93
PASC-H-RCAp:01313	Saturation pH @ 4C	9.85	9.8	8.62	10.2	9.53
PASC-H-RCAp:01314	Saturation pH @ 20C	9.45	9.4	8.22	9.77	9.13
PASC-H-RCAp:02010	Aluminum	120	130	140	410	460
PASC-H-RCAp:02020	Antimony	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02030	Arsenic	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02040	Barium	23	22	63	16	17
PASC-H-RCAp:02050	Beryllium	< 5	< 5	< 5	< 5	< 5
PASC-H-RCAp:02060	Bismuth	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02070	Boron	6	6	8	6	11
PASC-H-RCAp:02080	Cadmium	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
PASC-H-RCAp:02090	Chromium	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02100	Cobalt	< 1	< 1	< 1	< 1	< 1
PASC-H-RCAp:02110	Copper	3	2	4	3	3
PASC-H-RCAp:02130	Iron	150	160	140	290	350
PASC-H-RCAp:02140	Lead	< 0.5	< 0.5	< 0.5	< 0.5	0.5
PASC-H-RCAp:02150	Manganese	19	17	11	9	16
PASC-H-RCAp:02160	Molybdenum	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02170	Nickel	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02180	Selenium	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02200	Silver	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
PASC-H-RCAp:02220	Strontium	72	73	72	15	74
PASC-H-RCAp:02230	Thallium	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
PASC-H-RCAp:02240	Tin	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02250	Titanium	2	3	3	11	11
PASC-H-RCAp:02260	Uranium	< 0.1	< 0.1	0.1	< 0.1	0.1
PASC-H-RCAp:02270	Vanadium	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02280	Zinc	10	5	12	26	11
PASC-H-RCAp:04060	Phosphorus	< 0.1	< 0.1	< 0.1	0.1	< 0.1
PASC-H-RCAp:04070	Total Org. Carbon (by UV)	5.1	4.8	5.5	8.4	9.5
PASC-H-RCAp:50770	RCAp Comments	EQL for K elevated to <0.3 due to elevated blanks and	EQL for K elevated to <0.3 due to elevated blanks and	EQL for K elevated to <0.3 due to elevated blanks and	EQL for K elevated to <0.3 due to elevated blanks and	EQL for K elevated to <0.3 due to elevated blanks and

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

		12	13	14	15	15 DUP
		16949	16949	16949	16949	16949
	Date Generated	02-H067574	02-H067575	02-H067576	02-H067577	02-H067578
	9-Nov-2002	Water	Water	Water	Water	Water
	Spreadsheet File Name					02-H067577
	0216601H.XLS	31-Oct-02	31-Oct-02	31-Oct-02	31-Oct-02	31-Oct-02
	Parameters					
PASC-H-:01316	Total Suspended Solids	< 2	6	5	< 2	
PASC-H-:04823	Total Water Digest	20021101-B	20021101-B	20021101-B	20021101-B	20021101-B
PASC-H-:50920	Inorganic Comment					
PASC-H-RCAp:01010	Sodium	8.5	5.5	52.7	104	104
PASC-H-RCAp:01020	Potassium	1.4	7.9	4.6	0.8	0.7
PASC-H-RCAp:01030	Calcium	12	14.6	31.1	2.9	3
PASC-H-RCAp:01050	Magnesium	2.2	3.7	4.8	0.2	0.2
PASC-H-RCAp:01060	Alkalinity (as CaCO3)	17	42	110	20	21
PASC-H-RCAp:01070	Sulfate	28	19	19	36	32
PASC-H-RCAp:01080	Chloride	11	11	59	140	140
PASC-H-RCAp:01090	Reactive Silica (as SiO2)	3.2	2.9	3.9	2.4	2.3
PASC-H-RCAp:01100	Ortho Phosphate (as P)	0.02	0.29	0.15	0.02	0.02
PASC-H-RCAp:01105	Nitrite	< 0.01	0.02	< 0.01	< 0.01	< 0.01
PASC-H-RCAp:01110	Nitrate + Nitrite (as N)	< 0.05	0.29	0.13	< 0.05	< 0.05
PASC-H-RCAp:01115	Nitrate (as N)	< 0.05	0.27	0.13	< 0.05	< 0.05
PASC-H-RCAp:01120	Ammonia (as N)	< 0.05	0.65	< 0.05	< 0.05	< 0.05
PASC-H-RCAp:01170	Color	47	83	32	98	99
PASC-H-RCAp:01180	Turbidity	11.1	4.3	6	2.3	2.3
PASC-H-RCAp:01190	Conductance (RCAp)	132	146	470	596	594
PASC-H-RCAp:01200	pH	7.2	7.5	8	6.6	6.7
PASC-H-RCAp:01220	Hardness (as CaCO3)	39	51.7	97.4	8.1	8.3
PASC-H-RCAp:01230	Bicarbonate (as CaCO3)	17	42	109	20	21
PASC-H-RCAp:01240	Carbonate (as CaCO3)	< 1	< 1	1	< 1	< 1
PASC-H-RCAp:01250	TDS (Calculated)	77	92	242	299	295
PASC-H-RCAp:01270	Cation Sum	1.19	1.52	4.36	4.71	4.71
PASC-H-RCAp:01280	Anion Sum	1.24	1.57	4.27	5.1	5.04
PASC-H-RCAp:01290	Ion Balance	1.94	1.46	1.07	3.98	3.34
PASC-H-RCAp:01311	Langlier Index @ 4C	-2.32	-1.55	-0.33	-3.51	-3.37
PASC-H-RCAp:01312	Langlier Index @ 20C	-1.92	-1.15	0.07	-3.11	-2.97
PASC-H-RCAp:01313	Saturation pH @ 4C	9.52	9.05	8.33	10.1	10.1
PASC-H-RCAp:01314	Saturation pH @ 20C	9.12	8.65	7.93	9.71	9.67
PASC-H-RCAp:02010	Aluminum	390	170	90	410	460
PASC-H-RCAp:02020	Antimony	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02030	Arsenic	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02040	Barium	17	17	47	28	29
PASC-H-RCAp:02050	Beryllium	< 5	< 5	< 5	< 5	< 5
PASC-H-RCAp:02060	Bismuth	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02070	Boron	13	10	8	< 5	< 5
PASC-H-RCAp:02080	Cadmium	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
PASC-H-RCAp:02090	Chromium	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02100	Cobalt	< 1	< 1	< 1	< 1	< 1
PASC-H-RCAp:02110	Copper	2	3	4	8	8
PASC-H-RCAp:02130	Iron	340	180	110	630	650
PASC-H-RCAp:02140	Lead	< 0.5	< 0.5	0.6	1.7	1.7
PASC-H-RCAp:02150	Manganese	17	29	21	25	25
PASC-H-RCAp:02160	Molybdenum	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02170	Nickel	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02180	Selenium	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02200	Silver	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
PASC-H-RCAp:02220	Strontium	80	59	96	9	9
PASC-H-RCAp:02230	Thallium	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
PASC-H-RCAp:02240	Tin	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02250	Titanium	9	4	3	7	11
PASC-H-RCAp:02260	Uranium	< 0.1	< 0.1	0.2	< 0.1	< 0.1
PASC-H-RCAp:02270	Vanadium	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02280	Zinc	5	7	6	8	7
PASC-H-RCAp:04060	Phosphorus	< 0.1	0.3	0.1	< 0.1	< 0.1
PASC-H-RCAp:04070	Total Org. Carbon (by UV)	9.6	16.5	8.1	12	13.4
PASC-H-RCAp:50770	RCAp Comments	EQL for K elevated to <0.3 due to elevated blanks and			EQL for K elevated to <0.3 due to elevated blanks and instrument precision.	EQL for K elevated to <0.3 due to elevated blanks and instrument precision.

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Prepared For:
JWEL

Date Generated
14-Feb-2003
Spreadsheet File Name
0301690h.XLS

Client ID:	1	2
Project ID:	16949-3	16949-3
PSC Analytical ID:	03-H006207	03-H006208
Matrix:	Water	Water
Duplicate of:		
Date Sampled:	6-Feb-03	6-Feb-03
Client Description:		

	Parameters	Method	EQL	Units		
PASC-H-:01316	Total Suspended Solids	Grav.	0.5	mg/L	< 2	4.5
PASC-H-:04823	Total Water Digest		-		20030207-B	20030207-B
PASC-H-:50920	Inorganic Comment	Comment		Text	Color; EQL = 10 due to elevated method blank.	
PASC-H-RCAp:01010	Sodium	ICP-OES	0.1	mg/L	3.6	39.2
PASC-H-RCAp:01020	Potassium	ICP-OES	0.1	mg/L	0.4	0.8
PASC-H-RCAp:01030	Calcium	ICP-OES	0.1	mg/L	1.3	11.7
PASC-H-RCAp:01050	Magnesium	ICP-OES	0.1	mg/L	0.7	2.1
PASC-H-RCAp:01060	Alkalinity (as CaCO3)	COBAS	5	mg/L	< 5	11
PASC-H-RCAp:01070	Sulfate	COBAS	2	mg/L	< 5	< 10
PASC-H-RCAp:01080	Chloride	COBAS	1	mg/L	6	66
PASC-H-RCAp:01090	Reactive Silica (as SiO2)	COBAS	0.5	mg/L	3	3.2
PASC-H-RCAp:01100	Ortho Phosphate (as P)	COBAS/911	0.01	mg/L	< 0.02	< 0.02
PASC-H-RCAp:01105	Nitrite	COBAS	0.01	mg/L	< 0.01	< 0.01
PASC-H-RCAp:01110	Nitrate + Nitrite (as N)	COBAS	0.05	mg/L	< 0.05	0.17
PASC-H-RCAp:01115	Nitrate (as N)	COBAS	0.05	mg/L	< 0.05	0.17
PASC-H-RCAp:01120	Ammonia (as N)	COBAS	0.05	mg/L	< 0.05	< 0.05
PASC-H-RCAp:01170	Color	COBAS	5	TCU	29	34
PASC-H-RCAp:01180	Turbidity	NEPH.	0.1	NTU	0.5	1.4
PASC-H-RCAp:01190	Conductance (RCAp)	Electrode	1	uS/cm	34	269
PASC-H-RCAp:01200	pH	Electrode	-	Units	5.7	6.4
PASC-H-RCAp:01220	Hardness (as CaCO3)	Calculated	0.1	mg/L	6.1	37.9
PASC-H-RCAp:01230	Bicarbonate (as CaCO3)	Calculated	1	mg/L	< 5	11
PASC-H-RCAp:01240	Carbonate (as CaCO3)	Calculated	1	mg/L	< 5	< 1
PASC-H-RCAp:01250	TDS (Calculated)	Calculated	1	mg/L	23	140
PASC-H-RCAp:01270	Cation Sum	Calculated	0.1	meq/L	0.29	2.49
PASC-H-RCAp:01280	Anion Sum	Calculated	0.1	meq/L	0.38	2.3
PASC-H-RCAp:01290	Ion Balance	Calculated	-	%	12.2	3.86
PASC-H-RCAp:01311	Langlier Index @ 4C	Calculated	-		-5.30	-3.34
PASC-H-RCAp:01312	Langlier Index @ 20C	Calculated	-		-4.90	-2.94
PASC-H-RCAp:01313	Saturation pH @ 4C	Calculated	-	Units	11	9.74
PASC-H-RCAp:01314	Saturation pH @ 20C	Calculated	-	Units	10.6	9.34
PASC-H-RCAp:02010	Aluminum	ICP-MS	10	ug/L	160	110
PASC-H-RCAp:02020	Antimony	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02030	Arsenic	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02040	Barium	ICP-MS	5	ug/L	11	20
PASC-H-RCAp:02050	Beryllium	ICP-MS	5	ug/L	< 5	< 5
PASC-H-RCAp:02060	Bismuth	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02070	Boron	ICP-MS	5	ug/L	< 5	5
PASC-H-RCAp:02080	Cadmium	ICP-MS	0.3	ug/L	< 0.3	< 0.3
PASC-H-RCAp:02090	Chromium	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02100	Cobalt	ICP-MS	1	ug/L	< 1	< 1
PASC-H-RCAp:02110	Copper	ICP-MS	2	ug/L	< 2	2
PASC-H-RCAp:02130	Iron	ICP-MS	20	ug/L	130	190
PASC-H-RCAp:02140	Lead	ICP-MS	0.5	ug/L	< 0.5	< 0.5
PASC-H-RCAp:02150	Manganese	ICP-MS	2	ug/L	26	53
PASC-H-RCAp:02160	Molybdenum	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02170	Nickel	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02180	Selenium	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02200	Silver	ICP-MS	0.5	ug/L	< 0.5	< 0.5
PASC-H-RCAp:02220	Strontium	ICP-MS	5	ug/L	5	37
PASC-H-RCAp:02230	Thallium	ICP-MS	0.1	ug/L	< 0.1	< 0.1
PASC-H-RCAp:02240	Tin	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02250	Titanium	ICP-MS	2	ug/L	2	2
PASC-H-RCAp:02260	Uranium	ICP-MS	0.1	ug/L	< 0.1	< 0.1
PASC-H-RCAp:02270	Vanadium	ICP-MS	2	ug/L	< 2	< 2
PASC-H-RCAp:02280	Zinc	ICP-MS	2	ug/L	5	6
PASC-H-RCAp:04060	Phosphorus	ICP-OES	0.1	mg/L	< 0.1	< 0.1
PASC-H-RCAp:04070	Total Org. Carbon (by UV)	U.V.-ox	0.5	mg/L	4.9	5.3
PASC-H-RCAp:50770	RCAp Comments	Comment		Text	Orthophosphorous; EQL = 0.02 due to elevated method blank.	Color; EQL = 10 due to elevated method blank. Orthophosphorous; EQL = 0.02 due to elevated method blank.

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Date Generated
14-Feb-2003
Spreadsheet File Name
0301690h.XLS

	Parameters	4 16949-3 03-H006209 Water 6-Feb-03	5 16949-3 03-H006210 Water 6-Feb-03	6 16949-3 03-H006211 Water 6-Feb-03
PASC-H-:01316	Total Suspended Solids	26.8	< 2	< 2
PASC-H-:04823	Total Water Digest	20030207-B	20030207-B	20030207-B
PASC-H-:50920	Inorganic Comment	Color; EQL = 10 due to elevated method blank.	Color; EQL = 10 due to elevated method blank.	
PASC-H-RCAp:01010	Sodium	214	80.3	60.7
PASC-H-RCAp:01020	Potassium	1.5	0.8	1.3
PASC-H-RCAp:01030	Calcium	38.9	15.8	28.5
PASC-H-RCAp:01050	Magnesium	3.7	1.9	4.2
PASC-H-RCAp:01060	Alkalinity (as CaCO3)	53	14	41
PASC-H-RCAp:01070	Sulfate	26	23	17
PASC-H-RCAp:01080	Chloride	300	120	91
PASC-H-RCAp:01090	Reactive Silica (as SiO2)	3	2.4	3.4
PASC-H-RCAp:01100	Ortho Phosphate (as P)	0.02	< 0.01	0.01
PASC-H-RCAp:01105	Nitrite	< 0.01	< 0.01	< 0.01
PASC-H-RCAp:01110	Nitrate + Nitrite (as N)	< 0.05	0.1	0.39
PASC-H-RCAp:01115	Nitrate (as N)	< 0.05	0.1	0.39
PASC-H-RCAp:01120	Ammonia (as N)	< 0.05	< 0.05	< 0.05
PASC-H-RCAp:01170	Color	23	35	27
PASC-H-RCAp:01180	Turbidity	11.4	4.2	5.3
PASC-H-RCAp:01190	Conductance (RCAp)	1280	512	445
PASC-H-RCAp:01200	pH	7.6	7	7.4
PASC-H-RCAp:01220	Hardness (as CaCO3)	112	47.3	88.5
PASC-H-RCAp:01230	Bicarbonate (as CaCO3)	53	14	41
PASC-H-RCAp:01240	Carbonate (as CaCO3)	< 1	< 1	< 1
PASC-H-RCAp:01250	TDS (Calculated)	619	253	232
PASC-H-RCAp:01270	Cation Sum	11.6	4.46	4.45
PASC-H-RCAp:01280	Anion Sum	10.1	4.15	3.77
PASC-H-RCAp:01290	Ion Balance	7.07	3.63	8.25
PASC-H-RCAp:01311	Langlier Index @ 4C	-0.99	-2.52	-1.39
PASC-H-RCAp:01312	Langlier Index @ 20C	-0.59	-2.12	-0.99
PASC-H-RCAp:01313	Saturation pH @ 4C	8.59	9.52	8.79
PASC-H-RCAp:01314	Saturation pH @ 20C	8.19	9.12	8.39
PASC-H-RCAp:02010	Aluminum	340	250	300
PASC-H-RCAp:02020	Antimony	< 2	< 2	< 2
PASC-H-RCAp:02030	Arsenic	< 2	< 2	< 2
PASC-H-RCAp:02040	Barium	100	38	52
PASC-H-RCAp:02050	Beryllium	< 5	< 5	< 5
PASC-H-RCAp:02060	Bismuth	< 2	< 2	< 2
PASC-H-RCAp:02070	Boron	8	5	10
PASC-H-RCAp:02080	Cadmium	< 0.3	< 0.3	< 0.3
PASC-H-RCAp:02090	Chromium	2	< 2	< 2
PASC-H-RCAp:02100	Cobalt	< 1	< 1	< 1
PASC-H-RCAp:02110	Copper	4	2	3
PASC-H-RCAp:02130	Iron	440	240	270
PASC-H-RCAp:02140	Lead	4.7	< 0.5	< 0.5
PASC-H-RCAp:02150	Manganese	36	14	90
PASC-H-RCAp:02160	Molybdenum	< 2	< 2	< 2
PASC-H-RCAp:02170	Nickel	< 2	< 2	< 2
PASC-H-RCAp:02180	Selenium	< 2	< 2	< 2
PASC-H-RCAp:02200	Silver	< 0.5	< 0.5	< 0.5
PASC-H-RCAp:02220	Strontium	74	34	96
PASC-H-RCAp:02230	Thallium	< 0.1	< 0.1	< 0.1
PASC-H-RCAp:02240	Tin	< 2	< 2	< 2
PASC-H-RCAp:02250	Titanium	12	6	10
PASC-H-RCAp:02260	Uranium	0.1	< 0.1	0.1
PASC-H-RCAp:02270	Vanadium	< 2	< 2	< 2
PASC-H-RCAp:02280	Zinc	10	8	21
PASC-H-RCAp:04060	Phosphorus	< 0.1	< 0.1	< 0.1
PASC-H-RCAp:04070	Total Org. Carbon (by UV)	3.1	4.6	2.8
PASC-H-RCAp:50770	RCAp Comments	Orthophosphorous; EQL = 0.02 due to elevated method blank. Excess cations due to presence of turbidity.		Color; EQL = 10 due to elevated method blank. Cation values verified by repeat analysis.

	Date Generated 14-Feb-2003 Spreadsheet File Name 0301690h.XLS	7 16949-3 03-H006212 Water 6-Feb-03	8 16949-3 03-H006213 Water 6-Feb-03	9 16949-3 03-H006214 Water 6-Feb-03	10 16949-3 03-H006215 Water 6-Feb-03	11 16949-3 03-H006216 Water 6-Feb-03
	Parameters					
PASC-H-:01316	Total Suspended Solids	2.2	2.5	7.8	< 2	3.2
PASC-H-:04823	Total Water Digest	20030207-B	20030207-B	20030207-B	20030207-B	20030207-B
PASC-H-:50920	Inorganic Comment					
PASC-H-RCAp:01010	Sodium	7.7	20.6	54.4	4.2	11.6
PASC-H-RCAp:01020	Potassium	0.6	0.9	2.8	1	0.9
PASC-H-RCAp:01030	Calcium	4.8	9.7	21	3.5	8.7
PASC-H-RCAp:01050	Magnesium	1.5	1.6	3.7	1.4	1.7
PASC-H-RCAp:01060	Alkalinity (as CaCO3)	8	16	40	10	12
PASC-H-RCAp:01070	Sulfate	10	16	16	11	20
PASC-H-RCAp:01080	Chloride	12	30	89	7	18
PASC-H-RCAp:01090	Reactive Silica (as SiO2)	2.7	3.5	5.6	2.6	2.1
PASC-H-RCAp:01100	Ortho Phosphate (as P)	0.01	0.01	0.03	0.02	0.02
PASC-H-RCAp:01105	Nitrite	< 0.01	0.02	0.02	0.02	0.02
PASC-H-RCAp:01110	Nitrate + Nitrite (as N)	0.13	0.26	< 0.05	0.62	< 0.05
PASC-H-RCAp:01115	Nitrate (as N)	0.13	0.24	< 0.05	0.6	< 0.05
PASC-H-RCAp:01120	Ammonia (as N)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
PASC-H-RCAp:01170	Color	32	19	31	33	36
PASC-H-RCAp:01180	Turbidity	5.4	3.1	12.5	6.9	9.9
PASC-H-RCAp:01190	Conductance (RCAp)	72	167	404	51	118
PASC-H-RCAp:01200	pH	6.7	6.8	7.4	6.7	6.7
PASC-H-RCAp:01220	Hardness (as CaCO3)	18.2	30.8	67.7	14.5	28.7
PASC-H-RCAp:01230	Bicarbonate (as CaCO3)	8	16	40	10	12
PASC-H-RCAp:01240	Carbonate (as CaCO3)	< 1	< 1	< 1	< 1	< 1
PASC-H-RCAp:01250	TDS (Calculated)	45	93	217	40	70
PASC-H-RCAp:01270	Cation Sum	0.72	1.54	3.79	0.5	1.11
PASC-H-RCAp:01280	Anion Sum	0.72	1.52	3.65	0.67	1.17
PASC-H-RCAp:01290	Ion Balance	0.1	0.69	1.99	14.4	2.72
PASC-H-RCAp:01311	Langlier Index @ 4C	-3.54	-2.85	-1.54	-3.58	-3.11
PASC-H-RCAp:01312	Langlier Index @ 20C	-3.14	-2.45	-1.14	-3.18	-2.71
PASC-H-RCAp:01313	Saturation pH @ 4C	10.2	9.65	8.94	10.3	9.81
PASC-H-RCAp:01314	Saturation pH @ 20C	9.84	9.25	8.54	9.88	9.41
PASC-H-RCAp:02010	Aluminum	320	150	410	400	490
PASC-H-RCAp:02020	Antimony	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02030	Arsenic	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02040	Barium	13	23	46	13	15
PASC-H-RCAp:02050	Beryllium	< 5	< 5	< 5	< 5	< 5
PASC-H-RCAp:02060	Bismuth	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02070	Boron	< 5	6	5	5	8
PASC-H-RCAp:02080	Cadmium	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
PASC-H-RCAp:02090	Chromium	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02100	Cobalt	< 1	< 1	< 1	< 1	< 1
PASC-H-RCAp:02110	Copper	2	2	5	5	2
PASC-H-RCAp:02130	Iron	290	170	470	310	390
PASC-H-RCAp:02140	Lead	< 0.5	< 0.5	1.8	< 0.5	< 0.5
PASC-H-RCAp:02150	Manganese	14	19	35	10	23
PASC-H-RCAp:02160	Molybdenum	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02170	Nickel	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02180	Selenium	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02200	Silver	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
PASC-H-RCAp:02220	Strontium	14	64	40	13	53
PASC-H-RCAp:02230	Thallium	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
PASC-H-RCAp:02240	Tin	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02250	Titanium	11	5	12	9	11
PASC-H-RCAp:02260	Uranium	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
PASC-H-RCAp:02270	Vanadium	< 2	< 2	< 2	< 2	< 2
PASC-H-RCAp:02280	Zinc	8	4	15	8	6
PASC-H-RCAp:04060	Phosphorus	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
PASC-H-RCAp:04070	Total Org. Carbon (by UV)	4.7	3.4	3.7	5.3	5
PASC-H-RCAp:50770	RCAp Comments	Color; EQL = 10 due to elevated method blank.				

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

		13	13 DUP
		16949-3	16949-3
	Date Generated 14-Feb-2003	03-H006217	03-H006218
		Water	Water
	Spreadsheet File Name 0301690h.XLS		03-H006217
		6-Feb-03	6-Feb-03
	Parameters		
PASC-H-:01316	Total Suspended Solids	8.5	
PASC-H-:04823	Total Water Digest	20030207-B	20030207-B
PASC-H-:50920	Inorganic Comment		
PASC-H-RCAp:01010	Sodium	3.5	3.6
PASC-H-RCAp:01020	Potassium	2.4	2.5
PASC-H-RCAp:01030	Calcium	8	8
PASC-H-RCAp:01050	Magnesium	2.1	2.2
PASC-H-RCAp:01060	Alkalinity (as CaCO3)	25	17
PASC-H-RCAp:01070	Sulfate	10	11
PASC-H-RCAp:01080	Chloride	7	6
PASC-H-RCAp:01090	Reactive Silica (as SiO2)	1.7	1.6
PASC-H-RCAp:01100	Ortho Phosphate (as P)	0.11	0.11
PASC-H-RCAp:01105	Nitrite	0.02	0.02
PASC-H-RCAp:01110	Nitrate + Nitrite (as N)	< 0.05	0.1
PASC-H-RCAp:01115	Nitrate (as N)	< 0.05	0.08
PASC-H-RCAp:01120	Ammonia (as N)	0.09	0.14
PASC-H-RCAp:01170	Color	34	34
PASC-H-RCAp:01180	Turbidity	5.3	5.5
PASC-H-RCAp:01190	Conductance (RCAp)	77	78
PASC-H-RCAp:01200	pH	7.3	7.2
PASC-H-RCAp:01220	Hardness (as CaCO3)	28.6	29
PASC-H-RCAp:01230	Bicarbonate (as CaCO3)	25	17
PASC-H-RCAp:01240	Carbonate (as CaCO3)	< 1	< 1
PASC-H-RCAp:01250	TDS (Calculated)	50	46
PASC-H-RCAp:01270	Cation Sum	0.79	0.81
PASC-H-RCAp:01280	Anion Sum	0.91	0.75
PASC-H-RCAp:01290	Ion Balance	6.86	4.23
PASC-H-RCAp:01311	Langlier Index @ 4C	-2.22	-2.49
PASC-H-RCAp:01312	Langlier Index @ 20C	-1.82	-2.09
PASC-H-RCAp:01313	Saturation pH @ 4C	9.52	9.69
PASC-H-RCAp:01314	Saturation pH @ 20C	9.12	9.29
PASC-H-RCAp:02010	Aluminum	210	220
PASC-H-RCAp:02020	Antimony	< 2	< 2
PASC-H-RCAp:02030	Arsenic	< 2	< 2
PASC-H-RCAp:02040	Barium	10	10
PASC-H-RCAp:02050	Beryllium	< 5	< 5
PASC-H-RCAp:02060	Bismuth	< 2	< 2
PASC-H-RCAp:02070	Boron	5	5
PASC-H-RCAp:02080	Cadmium	< 0.3	< 0.3
PASC-H-RCAp:02090	Chromium	< 2	< 2
PASC-H-RCAp:02100	Cobalt	< 1	< 1
PASC-H-RCAp:02110	Copper	2	2
PASC-H-RCAp:02130	Iron	240	260
PASC-H-RCAp:02140	Lead	< 0.5	< 0.5
PASC-H-RCAp:02150	Manganese	19	20
PASC-H-RCAp:02160	Molybdenum	< 2	< 2
PASC-H-RCAp:02170	Nickel	< 2	< 2
PASC-H-RCAp:02180	Selenium	< 2	< 2
PASC-H-RCAp:02200	Silver	< 0.5	< 0.5
PASC-H-RCAp:02220	Strontium	32	32
PASC-H-RCAp:02230	Thallium	< 0.1	< 0.1
PASC-H-RCAp:02240	Tin	< 2	< 2
PASC-H-RCAp:02250	Titanium	4	7
PASC-H-RCAp:02260	Uranium	< 0.1	< 0.1
PASC-H-RCAp:02270	Vanadium	< 2	< 2
PASC-H-RCAp:02280	Zinc	10	5
PASC-H-RCAp:04060	Phosphorus	0.2	0.2
PASC-H-RCAp:04070	Total Org. Carbon (by UV)	6.7	6.6
PASC-H-RCAp:50770	RCAp Comments		

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

PSC ANALYTICAL SERVICES

Prepared For:
Benoit LaLonde

Date Generated
30-Apr-2003
Spreadsheet File Name
0306333h.XLS

Client ID:	1	2
Project ID:	16949-3	16949-3
PSC Analytical ID:	03-H021187	03-H021188
Matrix:	Water	Water
Duplicate of:		
Date Sampled:	22-Apr-03	22-Apr-03
Client Description:		

	Parameters	Method	EQL	Units		
C-H-:0	Total Suspended Solids	Grav.	0.5	mg/L	< 2	< 2
C-H-:0	Total Water Digest		-		20030424-A	20030424-A
C-H-:5	Inorganic Comment	Comment		Text	ıg/L due to eleva	g/L due to eleva
-RCA	Sodium	ICP-OES	0.1	mg/L	3.4	21.5
-RCA	Potassium	ICP-OES	0.1	mg/L	0.3	0.6
-RCA	Calcium	ICP-OES	0.1	mg/L	1.3	8
-RCA	Magnesium	ICP-OES	0.1	mg/L	0.6	1.2
-RCA	Alkalinity (as CaCO3)	COBAS	5	mg/L	< 5	14
-RCA	Sulfate	COBAS	2	mg/L	4	12
-RCA	Chloride	COBAS	1	mg/L	5	34
-RCA	Reactive Silica (as SiO2)	COBAS	0.5	mg/L	1.9	0.5
-RCA	Ortho Phosphate (as P)	COBAS/911	0.01	mg/L	< 0.01	< 0.01
-RCA	Nitrite	COBAS	0.01	mg/L	< 0.01	< 0.01
-RCA	Nitrate + Nitrite (as N)	COBAS	0.05	mg/L	< 0.05	< 0.05
-RCA	Nitrate (as N)	COBAS	0.05	mg/L	< 0.05	< 0.05
-RCA	Ammonia (as N)	Auto Color	0.05	mg/L	< 0.05	< 0.05
-RCA	Color	COBAS	5	TCU	30	36
-RCA	Turbidity	NEPH.	0.1	NTU	2.7	0.3
-RCA	Conductance (RCAp)	Electrode	1	uS/cm	32	167
-RCA	pH	Electrode	-	Units	6.2	6.6
-RCA	Hardness (as CaCO3)	Calculated	0.1	mg/L	5.7	24.9
-RCA	Bicarbonate (as CaCO3)	Calculated	1	mg/L	< 5	14
-RCA	Carbonate (as CaCO3)	Calculated	1	mg/L	< 5	< 1
-RCA	TDS (Calculated)	Calculated	1	mg/L	20	86
-RCA	Cation Sum	Calculated	0.1	meq/L	0.27	1.45
-RCA	Anion Sum	Calculated	0.1	meq/L	0.33	1.49
-RCA	Ion Balance	Calculated	-	%	8.93	1.34
-RCA	Langlier Index @ 4C	Calculated	-		-4.80	-3.19
-RCA	Langlier Index @ 20C	Calculated	-		-4.40	-2.79
-RCA	Saturation pH @ 4C	Calculated	-	Units	11	9.79
-RCA	Saturation pH @ 20C	Calculated	-	Units	10.6	9.39
-RCA	Aluminum	ICP-MS	10	ug/L	190	50
-RCA	Antimony	ICP-MS	2	ug/L	< 2	< 2
-RCA	Arsenic	ICP-MS	2	ug/L	< 2	< 2
-RCA	Barium	ICP-MS	5	ug/L	11	13
-RCA	Beryllium	ICP-MS	2	ug/L	< 2	< 2
-RCA	Bismuth	ICP-MS	2	ug/L	< 2	< 2
-RCA	Boron	ICP-MS	5	ug/L	5	5
-RCA	Cadmium	ICP-MS	0.3	ug/L	< 0.3	< 0.3
-RCA	Chromium	ICP-MS	2	ug/L	< 2	< 2
-RCA	Cobalt	ICP-MS	1	ug/L	< 1	< 1
-RCA	Copper	ICP-MS	2	ug/L	2	2
-RCA	Iron	ICP-MS	50	ug/L	120	110
-RCA	Lead	ICP-MS	0.5	ug/L	< 0.5	< 0.5
-RCA	Manganese	ICP-MS	2	ug/L	14	8
-RCA	Molybdenum	ICP-MS	2	ug/L	< 2	< 2
-RCA	Nickel	ICP-MS	2	ug/L	< 2	< 2
-RCA	Selenium	ICP-MS	2	ug/L	< 2	< 2
-RCA	Silver	ICP-MS	0.5	ug/L	< 0.5	< 0.5

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

PSC ANALYTICAL SERVICES

Prepared For:
Benoit LaLonde

Date Generated
30-Apr-2003
Spreadsheet File Name
0306333h.XLS

	Client ID:				1	2
	Project ID:				16949-3	16949-3
	PSC Analytical ID:				03-H021187	03-H021188
	Matrix:				Water	Water
	Duplicate of:					
	Date Sampled:				22-Apr-03	22-Apr-03
	Client Description:					
	Parameters	Method	EQL	Units		
I-RCA	Strontium	ICP-MS	5	ug/L	5	26
I-RCA	Thallium	ICP-MS	0.1	ug/L	< 0.1	< 0.1
I-RCA	Tin	ICP-MS	2	ug/L	< 2	< 2
I-RCA	Titanium	ICP-MS	2	ug/L	2	< 2
I-RCA	Uranium	ICP-MS	0.1	ug/L	< 0.1	< 0.1
I-RCA	Vanadium	ICP-MS	2	ug/L	< 2	< 2
I-RCA	Zinc	ICP-MS	5	ug/L	5	< 5
I-RCA	Phosphorus	ICP-OES	0.1	mg/L	< 0.1	< 0.1
I-RCA	Total Org. Carbon (by UV)	U.V.-ox	0.5	mg/L	3.8	5.8
I-RCA	RCAp Comments	Comment		Text	Elevated EQL	

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Date Generated
30-Apr-2003
Spreadsheet File Name
0306333h.XLS

		3	4	5	6
		16949-3	16949-3	16949-3	16949-3
		03-H021189	03-H021190	03-H021191	03-H021192
		Water	Water	Water	Water
		22-Apr-03	22-Apr-03	22-Apr-03	22-Apr-03
	Parameters				
C-H-:0	Total Suspended Solids	5	< 2	2	2.8
C-H-:0	Total Water Digest	20030424-A	20030424-A	20030424-A	20030424-A
C-H-:5	Inorganic Comment	Colour EQL			
-RCA	Sodium	72.6	148	47.8	44.8
-RCA	Potassium	1.5	1.4	0.6	1.3
-RCA	Calcium	53.4	50.3	13	43.4
-RCA	Magnesium	5.2	4.4	1.7	6.2
-RCA	Alkalinity (as CaCO3)	110	130	20	44
-RCA	Sulfate	15	20	6	55
-RCA	Chloride	120	220	78	83
-RCA	Reactive Silica (as SiO2)	2.8	1.9	2.2	2.1
-RCA	Ortho Phosphate (as P)	< 0.01	< 0.01	< 0.01	< 0.01
-RCA	Nitrite	< 0.01	< 0.01	< 0.01	< 0.01
-RCA	Nitrate + Nitrite (as N)	< 0.05	< 0.05	< 0.05	< 0.05
-RCA	Nitrate (as N)	< 0.05	< 0.05	< 0.05	< 0.05
-RCA	Ammonia (as N)	< 0.05	< 0.05	< 0.05	< 0.05
-RCA	Color	13	17	31	17
-RCA	Turbidity	0.2	0.9	1.7	3
-RCA	Conductance (RCAp)	658	1060	331	516
-RCA	pH	7.9	8.1	7.4	7.8
-RCA	Hardness (as CaCO3)	155	144	39.5	134
-RCA	Bicarbonate (as CaCO3)	109	128	20	44
-RCA	Carbonate (as CaCO3)	< 1	2	< 1	< 1
-RCA	TDS (Calculated)	337	524	162	262
-RCA	Cation Sum	6.29	9.35	2.89	4.66
-RCA	Anion Sum	5.9	9.22	2.73	4.37
-RCA	Ion Balance	3.22	0.68	2.83	3.25
-RCA	Langlier Index @ 4C	-0.21	0.02	-2.04	-0.79
-RCA	Langlier Index @ 20C	0.19	0.42	-1.64	-0.39
-RCA	Saturation pH @ 4C	8.11	8.08	9.44	8.59
-RCA	Saturation pH @ 20C	7.71	7.68	9.04	8.19
-RCA	Aluminum	60	30	100	80
-RCA	Antimony	< 2	< 2	< 2	< 2
-RCA	Arsenic	< 2	< 2	< 2	< 2
-RCA	Barium	110	100	28	58
-RCA	Beryllium	< 2	< 2	< 2	< 2
-RCA	Bismuth	< 2	< 2	< 2	< 2
-RCA	Boron	8	< 5	7	12
-RCA	Cadmium	< 0.3	< 0.3	< 0.3	< 0.3
-RCA	Chromium	< 2	< 2	< 2	< 2
-RCA	Cobalt	< 1	< 1	< 1	< 1
-RCA	Copper	3	4	2	3
-RCA	Iron	50	< 50	160	210
-RCA	Lead	< 0.5	< 0.5	< 0.5	< 0.5
-RCA	Manganese	24	9	8	230
-RCA	Molybdenum	< 2	< 2	< 2	< 2
-RCA	Nickel	< 2	< 2	< 2	< 2
-RCA	Selenium	< 2	< 2	< 2	< 2
-RCA	Silver	< 0.5	< 0.5	< 0.5	< 0.5

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

		3	4	5	6
		16949-3	16949-3	16949-3	16949-3
	Date Generated	03-H021189	03-H021190	03-H021191	03-H021192
	30-Apr-2003	Water	Water	Water	Water
	Spreadsheet File Name				
	0306333h.XLS	22-Apr-03	22-Apr-03	22-Apr-03	22-Apr-03
	Parameters				
-RCA	Strontium	58	73	28	190
-RCA	Thallium	< 0.1	< 0.1	< 0.1	< 0.1
-RCA	Tin	< 2	< 2	< 2	< 2
-RCA	Titanium	2	< 2	3	3
-RCA	Uranium	0.7	0.4	< 0.1	0.1
-RCA	Vanadium	< 2	< 2	< 2	< 2
-RCA	Zinc	< 5	< 5	7	9
-RCA	Phosphorus	0.1	< 0.1	< 0.1	< 0.1
-RCA	Total Org. Carbon (by UV)	2	2.5	5	2.8
-RCA	RCAp Comments				

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

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	Date Generated 30-Apr-2003 Spreadsheet File Name 0306333h.XLS	7 16949-3 03-H021193 Water 22-Apr-03	8 16949-3 03-H021194 Water 22-Apr-03	9 16949-3 03-H021195 Water 22-Apr-03	10 16949-3 03-H021196 Water 22-Apr-03
	Parameters				
C-H-:0	Total Suspended Solids	3.5	< 2	4.5	2.5
C-H-:0	Total Water Digest	20030424-A	20030424-A	20030424-B	20030424-B
C-H-:5	Inorganic Comment				
I-RCA	Sodium	8	19.7	11.1	4.1
I-RCA	Potassium	0.6	0.5	0.7	0.9
I-RCA	Calcium	7	11.1	5.2	3.8
I-RCA	Magnesium	2	1.1	1.3	1.3
I-RCA	Alkalinity (as CaCO3)	18	9	9	8
I-RCA	Sulfate	4	17	8	5
I-RCA	Chloride	12	29	15	5
I-RCA	Reactive Silica (as SiO2)	0.8	4.2	2.5	1.6
I-RCA	Ortho Phosphate (as P)	0.02	< 0.01	0.03	0.02
I-RCA	Nitrite	< 0.01	0.01	0.01	< 0.01
I-RCA	Nitrate + Nitrite (as N)	< 0.05	0.1	< 0.05	0.61
I-RCA	Nitrate (as N)	< 0.05	0.09	< 0.05	0.61
I-RCA	Ammonia (as N)	< 0.05	< 0.05	< 0.05	< 0.05
I-RCA	Color	36	13	31	34
I-RCA	Turbidity	4.3	1.7	7.7	6.2
I-RCA	Conductance (RCAp)	91	174	91	54
I-RCA	pH	7.2	7.2	7.1	6.9
I-RCA	Hardness (as CaCO3)	25.7	32.2	18.3	14.8
I-RCA	Bicarbonate (as CaCO3)	18	9	9	8
I-RCA	Carbonate (as CaCO3)	< 1	< 1	< 1	< 1
I-RCA	TDS (Calculated)	45	89	49	29
I-RCA	Cation Sum	0.88	1.52	0.87	0.5
I-RCA	Anion Sum	0.79	1.36	0.77	0.45
I-RCA	Ion Balance	5.75	5.54	5.96	5.59
I-RCA	Langlier Index @ 4C	-2.52	-2.64	-3.05	-3.43
I-RCA	Langlier Index @ 20C	-2.12	-2.24	-2.65	-3.03
I-RCA	Saturation pH @ 4C	9.72	9.84	10.2	10.3
I-RCA	Saturation pH @ 20C	9.32	9.44	9.75	9.93
I-RCA	Aluminum	180	70	250	240
I-RCA	Antimony	< 2	< 2	< 2	< 2
I-RCA	Arsenic	< 2	< 2	< 2	< 2
I-RCA	Barium	16	22	15	11
I-RCA	Beryllium	< 2	< 2	< 2	< 2
I-RCA	Bismuth	< 2	< 2	< 2	< 2
I-RCA	Boron	< 5	6	< 5	5
I-RCA	Cadmium	< 0.3	< 0.3	< 0.3	< 0.3
I-RCA	Chromium	< 2	< 2	< 2	< 2
I-RCA	Cobalt	< 1	< 1	< 1	< 1
I-RCA	Copper	2	2	5	3
I-RCA	Iron	320	80	290	230
I-RCA	Lead	< 0.5	< 0.5	0.5	< 0.5
I-RCA	Manganese	29	12	12	8
I-RCA	Molybdenum	< 2	< 2	< 2	< 2
I-RCA	Nickel	< 2	< 2	< 2	< 2
I-RCA	Selenium	< 2	< 2	< 2	< 2
I-RCA	Silver	< 0.5	< 0.5	< 0.5	< 0.5

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Date Generated
30-Apr-2003
Spreadsheet File Name
0306333h.XLS

		7	8	9	10
		16949-3	16949-3	16949-3	16949-3
		03-H021193	03-H021194	03-H021195	03-H021196
		Water	Water	Water	Water
		22-Apr-03	22-Apr-03	22-Apr-03	22-Apr-03
	Parameters				
-RCA	Strontium	20	88	11	12
-RCA	Thallium	< 0.1	< 0.1	< 0.1	< 0.1
-RCA	Tin	< 2	< 2	< 2	< 2
-RCA	Titanium	4	2	4	5
-RCA	Uranium	< 0.1	< 0.1	< 0.1	< 0.1
-RCA	Vanadium	< 2	< 2	< 2	< 2
-RCA	Zinc	7	< 5	5	5
-RCA	Phosphorus	< 0.1	0.1	0.1	< 0.1
-RCA	Total Org. Carbon (by UV)	5.4	1.4	4	4.5
-RCA	RCAp Comments				

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

		11	11 DUP	12	13
		16949-3	16949-3	16949-3	16949-3
	Date Generated	03-H021197	03-H021198	03-H021199	03-H021200
	30-Apr-2003	Water	Water	Water	Water
	Spreadsheet File Name		03-H021197		
	0306333h.XLS	22-Apr-03	22-Apr-03	22-Apr-03	22-Apr-03
	Parameters				
C-H-:0	Total Suspended Solids	20.2		4.8	5
C-H-:0	Total Water Digest	20030424-B	20030424-B	20030424-B	20030424-B
C-H-:5	Inorganic Comment				
I-RCA	Sodium	16.5	17	10.1	16.8
I-RCA	Potassium	1	1.2	1	2.8
I-RCA	Calcium	16.6	17	13.7	13.3
I-RCA	Magnesium	2.8	2.9	2.3	2.9
I-RCA	Alkalinity (as CaCO3)	18	17	13	32
I-RCA	Sulfate	42	41	34	4
I-RCA	Chloride	22	22	11	20
I-RCA	Reactive Silica (as SiO2)	1.4	1.4	1.4	1.3
I-RCA	Ortho Phosphate (as P)	0.02	0.02	0.02	0.07
I-RCA	Nitrite	0.02	< 0.01	0.01	0.02
I-RCA	Nitrate + Nitrite (as N)	< 0.05	< 0.05	< 0.05	0.37
I-RCA	Nitrate (as N)	< 0.05	< 0.05	< 0.05	0.35
I-RCA	Ammonia (as N)	< 0.05	< 0.05	< 0.05	< 0.05
I-RCA	Color	39	39	40	33
I-RCA	Turbidity	22.8	23.2	12.1	9.3
I-RCA	Conductance (RCAp)	195	194	143	149
I-RCA	pH	7.4	7.4	7.2	7.5
I-RCA	Hardness (as CaCO3)	53	54.4	43.7	45.1
I-RCA	Bicarbonate (as CaCO3)	18	17	13	32
I-RCA	Carbonate (as CaCO3)	< 1	< 1	< 1	< 1
I-RCA	TDS (Calculated)	113	113	82	82
I-RCA	Cation Sum	1.81	1.86	1.34	1.71
I-RCA	Anion Sum	1.86	1.82	1.28	1.31
I-RCA	Ion Balance	1.41	1.2	2.31	13.1
I-RCA	Langlier Index @ 4C	-1.97	-1.98	-2.38	-1.71
I-RCA	Langlier Index @ 20C	-1.57	-1.58	-1.98	-1.31
I-RCA	Saturation pH @ 4C	9.37	9.38	9.58	9.21
I-RCA	Saturation pH @ 20C	8.97	8.98	9.18	8.81
I-RCA	Aluminum	730	880	360	180
I-RCA	Antimony	< 2	< 2	< 2	< 2
I-RCA	Arsenic	< 2	< 2	< 2	< 2
I-RCA	Barium	28	28	17	16
I-RCA	Beryllium	< 2	< 2	< 2	< 2
I-RCA	Bismuth	< 2	< 2	< 2	< 2
I-RCA	Boron	13	12	12	6
I-RCA	Cadmium	< 0.3	< 0.3	< 0.3	< 0.3
I-RCA	Chromium	< 2	< 2	< 2	< 2
I-RCA	Cobalt	< 1	1	< 1	< 1
I-RCA	Copper	3	3	2	3
I-RCA	Iron	930	1100	380	200
I-RCA	Lead	1.4	1.6	< 0.5	< 0.5
I-RCA	Manganese	110	120	34	8
I-RCA	Molybdenum	< 2	< 2	< 2	< 2
I-RCA	Nickel	< 2	2	< 2	< 2
I-RCA	Selenium	< 2	< 2	< 2	< 2
I-RCA	Silver	< 0.5	< 0.5	< 0.5	< 0.5

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

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		11	11 DUP	12	13
		16949-3	16949-3	16949-3	16949-3
	Date Generated	03-H021197	03-H021198	03-H021199	03-H021200
	30-Apr-2003	Water	Water	Water	Water
	Spreadsheet File Name		03-H021197		
	0306333h.XLS	22-Apr-03	22-Apr-03	22-Apr-03	22-Apr-03
	Parameters				
-RCA	Strontium	110	120	100	50
-RCA	Thallium	< 0.1	< 0.1	< 0.1	< 0.1
-RCA	Tin	< 2	< 2	< 2	< 2
-RCA	Titanium	11	15	7	4
-RCA	Uranium	0.1	0.1	< 0.1	< 0.1
-RCA	Vanadium	< 2	< 2	< 2	< 2
-RCA	Zinc	9	9	6	< 5
-RCA	Phosphorus	0.1	< 0.1	< 0.1	0.2
-RCA	Total Org. Carbon (by UV)	4.5	4.5	4.6	5.8
-RCA	RCAp Comments				s verified by rep

PSC ANALY
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Date Generated
30-Apr-2003
Spreadsheet File Name
0306333h.XLS

		14	15
		16949-3	16949-3
		03-H021201	03-H021202
		Water	Water
		22-Apr-03	22-Apr-03
	Parameters		
C-H-:0	Total Suspended Solids	2.8	< 2
C-H-:0	Total Water Digest	20030424-B	20030424-B
C-H-:5	Inorganic Comment		
-RCA	Sodium	124	27.4
-RCA	Potassium	4.5	0.7
-RCA	Calcium	47.4	4.8
-RCA	Magnesium	6.6	1.3
-RCA	Alkalinity (as CaCO3)	120	6
-RCA	Sulfate	9	4
-RCA	Chloride	190	46
-RCA	Reactive Silica (as SiO2)	2.7	2.7
-RCA	Ortho Phosphate (as P)	0.09	< 0.01
-RCA	Nitrite	< 0.01	< 0.01
-RCA	Nitrate + Nitrite (as N)	0.33	< 0.05
-RCA	Nitrate (as N)	0.33	< 0.05
-RCA	Ammonia (as N)	< 0.05	< 0.05
-RCA	Color	18	27
-RCA	Turbidity	2.8	0.8
-RCA	Conductance (RCAp)	955	186
-RCA	pH	8.1	6.7
-RCA	Hardness (as CaCO3)	146	17.3
-RCA	Bicarbonate (as CaCO3)	119	6
-RCA	Carbonate (as CaCO3)	1	< 1
-RCA	TDS (Calculated)	458	91
-RCA	Cation Sum	8.42	1.56
-RCA	Anion Sum	7.97	1.5
-RCA	Ion Balance	2.76	1.83
-RCA	Langlier Index @ 4C	-0.03	-3.68
-RCA	Langlier Index @ 20C	0.37	-3.28
-RCA	Saturation pH @ 4C	8.13	10.4
-RCA	Saturation pH @ 20C	7.73	9.98
-RCA	Aluminum	70	120
-RCA	Antimony	< 2	< 2
-RCA	Arsenic	< 2	< 2
-RCA	Barium	82	38
-RCA	Beryllium	< 2	< 2
-RCA	Bismuth	< 2	< 2
-RCA	Boron	7	5
-RCA	Cadmium	< 0.3	< 0.3
-RCA	Chromium	< 2	< 2
-RCA	Cobalt	< 1	< 1
-RCA	Copper	4	3
-RCA	Iron	110	210
-RCA	Lead	0.8	< 0.5
-RCA	Manganese	82	32
-RCA	Molybdenum	< 2	< 2
-RCA	Nickel	< 2	< 2
-RCA	Selenium	< 2	< 2
-RCA	Silver	< 0.5	< 0.5

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

Date Generated
30-Apr-2003
Spreadsheet File Name
0306333h.XLS

	Parameters	14 16949-3 03-H021201 Water 22-Apr-03	15 16949-3 03-H021202 Water 22-Apr-03
-RCA	Strontium	130	23
-RCA	Thallium	< 0.1	< 0.1
-RCA	Tin	< 2	< 2
-RCA	Titanium	3	< 2
-RCA	Uranium	0.3	< 0.1
-RCA	Vanadium	< 2	< 2
-RCA	Zinc	< 5	8
-RCA	Phosphorus	0.2	< 0.1
-RCA	Total Org. Carbon (by UV)	3.1	4.3
-RCA	RCAp Comments		

All results expressed on a dry weight basis for soils and a wet weight (as received) basis for tissues.

APPENDIX E

HIGHWAY 104 ANTIGONISH SOUTH RIVER IMPACT STUDY

Nova Scotia Department of Transportation and Public Works

FINAL REPORT
HIGHWAY 104 ANTIGONISH
SOUTH RIVER IMPACT STUDY

Prepared by:
Neill and Gunter (Nova Scotia) Limited
P.O. Box 2190 East
Dartmouth, NS B2W 3Y2

NGNS Job # 16053

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EXECUTIVE SUMMARY

Introduction

The purpose of the work described in this report was to carry out a detailed analysis of the proposed South River Crossing for what is known as the "Blue Route" for Highway 104 approximately 6 kilometres east of Antigonish. The analysis was to determine the magnitude and extent of environmental impacts, what mitigation measures might be required, and the cost implications. In addition, a proposed general arrangement of the bridge structure was prepared.

The work consisted of field work, data analysis, environmental impact prediction, conceptual design, and mitigation planning for the proposed bridge structure. The study involved detailed work in the following areas:

- Geology and Physiology;
- Hydrology;
- Vegetation;
- Benthic Invertebrates;
- Fish and Aquatic Habitat;
- Amphibians and Reptiles;
- Birds;
- Mammals;
- Rare or Endangered Species; and
- Coastal Freshwater Marsh.

Environmental Findings

The South River appears to define the geological contact between limestone bedrock on the west and siltstone bedrock on the east. The potential for Karst topography is greater in the limestone bedrock. Notwithstanding, Karst topography was not encountered during the borehole program carried out for this assessment.

The hydrologic functions of the South River at this location are primarily for conveyance and flood storage purposes. Construction of the bridge will not impact conveyance and will displace a negligible amount of flood storage capacity.

The study site is a highly productive tidal section of the South River. The mixing of denser saltwater provides nutrients to support aquatic production, which in turn provides food to mummichogs, a small common estuarine fish found in high numbers in the area. The site does not, however, provide critical habitat, such as spawning or breeding areas, for important species. Many species of birds and estuarine fish species feed in the area, and a number of highly valued recreational fish species migrate upstream and downstream in the spring and fall.

The study site also has an interesting diversity of species because of its mix of fresh and salt water. For example, both fresh and salt water tolerant species of invertebrates are found in the river substrate. Plant diversity, however, is predominantly salt intolerant, indicating that the area should not be classified as salt marsh.

In terms of unique habitats, the study site is typical of many small sections of Nova Scotia estuaries. Nearby Pomquet estuary provides more unique habitats and supports a number of rare and endangered species. Uncommon species, such as the Nelson Sharp-Tailed sparrow, do occur in the area of the study site, but none are known to be dependent on the site for reproduction.

Within the South River, areas upstream and downstream of the study site provide more critical habitat, especially spawning habitat for fish and breeding habitat for birds. The true salt marsh area downstream of the study site is definitely more important in terms of waterfowl. Above the head of tide, spawning habitat for salmonids, especially the increasingly threatened Atlantic salmon, occurs in many areas.

Construction of a bridge within the study site is less likely to have significant environmental impacts than a site upstream or downstream.

Proposed Structure

A four-span steel girder structural system with a concrete deck was proposed. The use of weathering steel has some advantages in terms of foundation loading where karst conditions are possible and provides a relatively maintenance free structural system.

The major elements of the structure consist of the following:

- Four 60 m spans of weathered steel
- Abutments at the east and west ends of the structure
- Piers and abutments founded on piles
- Concrete deck
- Jersey barrier style guard rails

The estimated cost to the structure was in the order of $5,500,000. The bridge structure layout was designed to avoid impacting on the main channel of South River because of its function in the local fishery. The only residual impact of the bridge will be the displacement of approximately 2,500 m^2 of marsh area primarily from the island marsh habitat located between the back and main channels.

A Certificate of Approval under the Fisheries Act should not be required because there will be no net loss of aquatic habitat. Application will be required under the Navigable Waters Protection Act, although it is anticipated that approval will not be required under this act either.

1.0 INTRODUCTION

1.1 Background

The Nova Scotia Department of Transportation and Public Works (NSTPW) has been carrying out a Highway Planning Process for Highway 104 from Antigonish to Lower South River. The NSTPW considered three alignment options for this area and after evaluation of numerous impact factors approved one for environmental assessment registration. This route is known as the "Blue Route". The preferred alignment crosses the South River approximately six kilometres east of the Town of Antigonish just downstream of the existing Highway 104. There were concerns regarding the environmental impact of the South River crossing at this location. The purpose of the work described in this report was to carry out a detailed analysis of the proposed South River Crossing at this location to determine the magnitude and extent of environmental impacts, what mitigation measures might be required, and the cost implications. The general location of the study area is indicated on Figure 1.

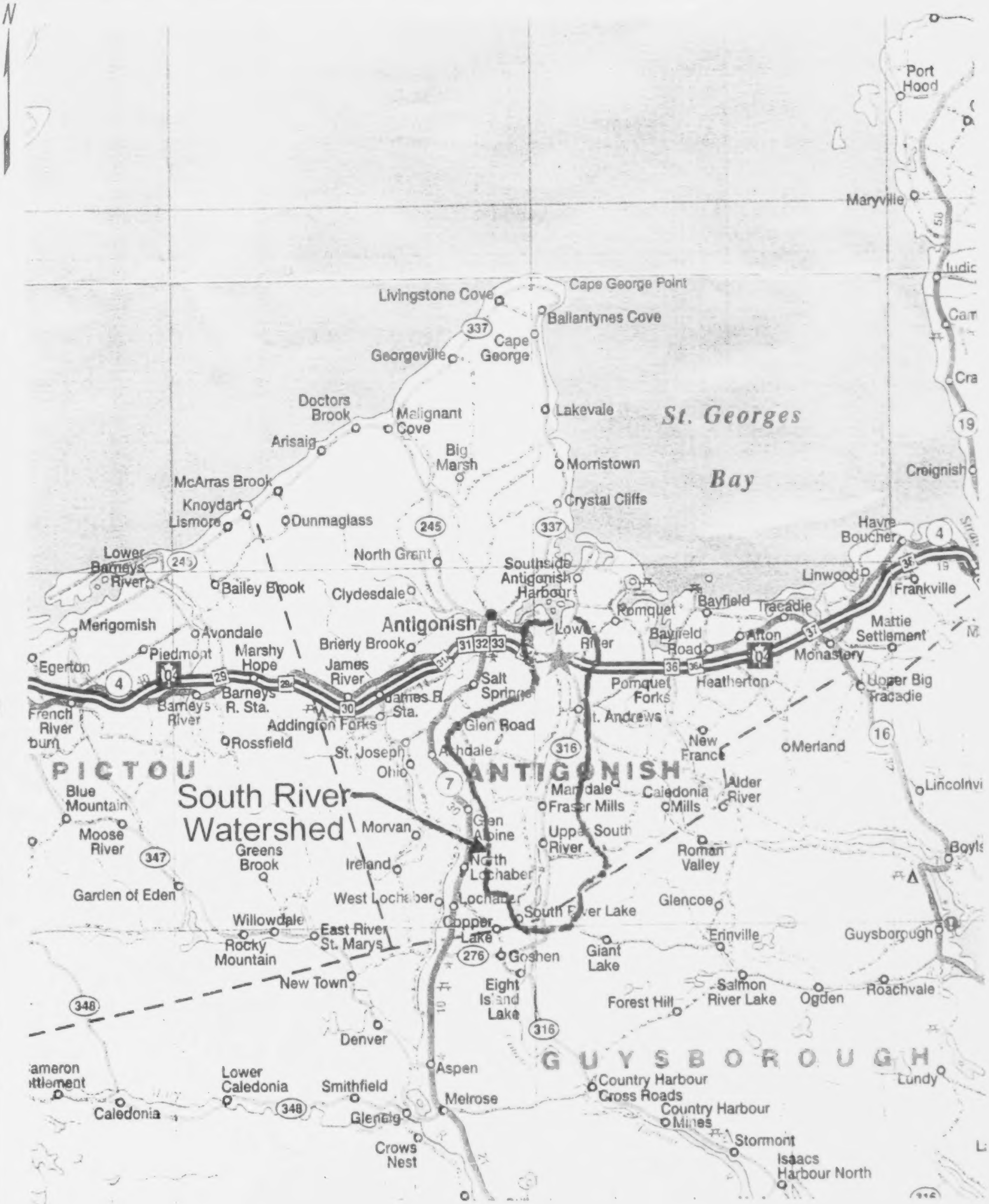
1.2 Study Objectives

The primary objectives for this project as defined in the terms of reference were as follows:

- Identify the environmental impacts of the recommended Blue Route on South River including the salt marsh habitat;
- Identify any previously undetected avoidance constraints within the study area that may force realignment of the recommended Blue Route;
- Determine the environmental and other mitigation measures required at the South River Crossing including associated costs; and
- Determine the general configuration of the structures (two 2-lane structures) at South River including preliminary cost estimates.

1.3 Report Contents

Chapter 1 (this chapter) provides a brief introduction to the project and the objectives of this report. The methodology used to carry out the field analysis and impact assessment is presented in Chapter 2. Chapter 3 provides a detailed description of the study area in terms of the biophysical and social environments. An evaluation of the wetland is provided in Chapter 4. Chapter 5 draws together the Valued Environmental Components (VECs) that emerged through the data analysis and wetland evaluation. Chapter 6 provides the guiding principles for, and the conceptual design of, the bridge structure. Chapter 7 provides recommendations for impact mitigation both during construction and operation of the new structure. Finally, conclusions are provided in Chapter 8.



HWY. 104 SOUTH RIVER
ENVIRONMENTAL IMPACT ASESSMENT

STUDY AREA LOCATION

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Neill and Gunter
DARTMOUTH, N.S., CANADA

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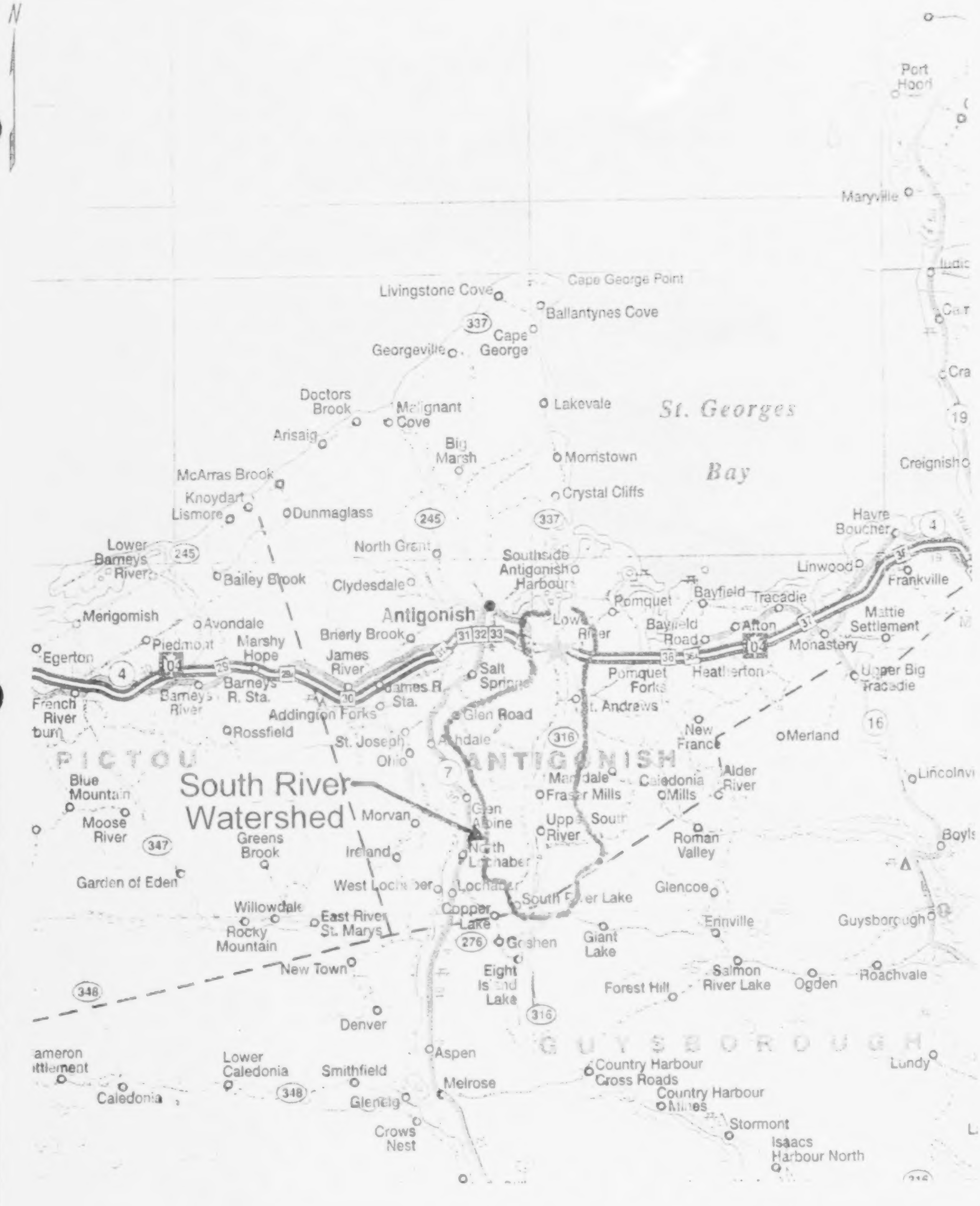

HWY. 104 SOUTH RIVER
ENVIRONMENTAL IMPACT ASESSMENT

Neill and Gunter
DARTMOUTH, N.S., CANADA

DATE DEC. 6/00	SCALE N.T.S.	JOB NO 16053
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STUDY AREA LOCATION

2.0 METHODOLOGY

The methodology used to carry out the environmental assessment work consisted of the following tasks:

- Field Survey and Data Collection;
- Sensitivity Analysis;
- Conceptual Design
- Impact Analysis; and
- Mitigation Plan.

The methodology used for each of these tasks are discussed in the following sections.

2.1 Field Survey and Data Collection

The data collection and field program was carried out in order to assess the environmental sensitivities of the study area. Field work was carried out according to the following schedule.

September 29 – Hydrology, water quality, set minnow traps, flora and fauna survey
October 4 – Hydrology and water quality
October 5 – Aquatic species and habitat survey, water quality
October 14 – Bird survey
October 19 – Geological Investigation/Drilling program
October 20 & 21 – Archaeological investigations

The specific tasks undertaken in each field of investigation are described in the following sections.

Physiography/Geology

Detailed geological mapping available from the Nova Scotia Department of Natural Resources was reviewed and a reconnaissance was conducted of the surrounding environs.

A drilling program consisting of two boreholes to depths of 15 to 20 m at the location of the approaches on both sides of the river was carried out. The holes were advanced with a CME75 drill rig operated by Logan Geotech of Enfield, Nova Scotia. The two Boreholes were augered and split spoon samples were collected from surface to bedrock. Bedrock was cored and visually inspected for karst topography and subsurface geology. Borehole locations are indicated on Map 1.

Stream Profiles/Hydrology

Existing hydraulic information for South River was obtained from the Department of Fisheries and Oceans. The measurement station was at St. Andrews (approximately 4 km upstream of Highway 104) – Station No. 01DR001 and had a period of record dating back to 1917 excluding 1934 to 1964.

Stream gauging was carried out across two transects of the main channel using a Watermark Velocity Meter with digital read out. A velocity profile and cross section was developed for each transect. A portable salinity meter (Beckman RS5) was used to measure salinity, conductivity and temperature at several locations in the main channel and back channel. A salinity profile was prepared for both the main and back channel areas.

Vegetation

The vegetation survey was conducted by Jim Jotcham. Two areas were surveyed, these were the 'island'; a fresh-water/brackish marsh with a wooded center, and the river banks; a mixed/hardwood forest with a hayfield on the west side. The results of the survey are tabulated in Appendix A.

Benthic Invertebrates

Benthic samples of Lower South River were collected by Norval Collins of CEF Consultants Ltd. and analyzed by Pat Stewart of Envirosphere Consultants Ltd. (Appendix B). Sediment and benthic samples were taken using a stainless Ponar (grab) sampler from a canoe at seven sampling stations in the marsh. The grab sampler has an effective surface sampling area of $0.03m^2$. Samples were transferred to a plastic ziplock bag. Analysis of particle size and enumeration and identification of invertebrates were completed by Envirosphere Consultants in Windsor, Nova Scotia.

Fish and Aquatic Habitat

The fish survey was conducted by Norval Collins and James Thorbourne. Minnow traps were set by Norval Collins at six locations throughout the marsh on 29 September, and were retrieved by Norval Collins and James Thorbourne on October 5th. Fish were identified, counted and measured at the site and several were taken back in a cooler for identification by John Gilhen of the Nova Scotia Museum of Natural History.

Visits were made to Shane O'Neil of the Bedford Institute of Oceanography (BIO) and to John Gilhen in order to get information on fish species that are known to occur in South River. Don McLean and Charles MacInnis of the Department of Fisheries and Ocean were also consulted by telephone. Previous reports of the South River area were referred to in order to obtain a better representation of fish species.

Amphibians and Reptiles

John Gilhen of the Nova Scotia Museum of Natural History was visited in order to obtain information on herpetile species known to occur in the South River area.

Birds

The bird survey was completed by Randy Lauff on October 14th. The personal records of Mr. Lauff (who resides in the area and commutes to work daily past the study site), historic Christmas Bird Count data (the site is at the center of the Antigonish Christmas Bird Count which has run for 25 years), the Atlas of Breeding Birds data (Erskine 1992; Appendix C), and the known habitat affiliations of birds, were used to give an overall picture of the use of the site. The Canadian Land Inventory provided general grading of the capability for waterfowl in the area.

Mammals

The Canadian Land Inventory, The Natural History of Nova Scotia: Northumberland Plain and Antigonish Upland theme regions, and Dalhousie University's Technical Report for Maintenance of Beaches: Pomquet, Antigonish County were used as sources for mammal habitat and occurrence in the area.

Wetland Evaluation

The wetland evaluation considered the various possible functions of the wetland, and then examined the potential impact of the proposed project on each of them. The study site was considered as part of a regional complex and its relative uniqueness was determined. In this regard, the wetland area was assessed in terms of its relationship to other wetlands in St. Georges Bay. The evaluation process also considered the principle of critical values, "a service or function that is very important to society or where an important threshold or function may be exceeded, resulting in the loss of the function and value".

Major wetland components that were evaluated include biological, hydrological and social/cultural.

Biological assessments centered around the role of the wetland in contributing to the well-being of plants, benthic macroinvertebrates, fish, migratory birds, reptiles, amphibians, and mammals. From an ecological perspective, the assessment considered the role of the study site within its complete landscape and regional setting.

Hydrological assessment centered around the value of the wetland in contributing to surface and groundwater stocks and the value of the wetland in contributing to surface water and groundwater quality.

The social/cultural assessment considered aesthetic, recreational, education and public awareness, public status or cultural values.

These three views are the primary basis for the overall assessment of the importance of the study site. In addition to these three views, potential use of the wetland for agriculture or other harvesting is considered.

Archaeological Assessment

The archaeological assessment of the study area was carried out by Davis Archaeological Consultants Ltd. and included background research, interviews, and field testing. Background research was completed at the Public Archives and the Nova Scotia Museum. Interviews were conducted with area residents and local historians. Field inspections and a test pitting program was conducted on October 20 and 21, 2000.

2.2 Analysis and Sensitivity Mapping

The culmination of the field work was the preparation of environmental sensitivity mapping of the study area and immediate environs. The sensitivity map was based on an interpretation of the background research and the scientific data collected during the field work. It included the following:

- Geological section through the study area indicating both bedrock and surficial deposits. Aquatic habitat types, fresh water, estuarine, salt water.
- Critical habitat for fish species and bird species.
- Typical salinity/conductivity profiles at high and low tides.
- Rare and/or endangered flora and fauna.
- Land use, archaeological significance

Valued Evironmental Components (VECs) were derived from the sensitivity mapping and the wetland evaluation process. The VECs were used as surrogates for the prediction of environmental impacts and the development of environmental design criteria for the bridge structure.

2.3 Conceptual Design

A conceptual design scenario that addressed underlying foundation conditions present, environmental conditions and future maintenance considerations was prepared. To effectively provide a design that met all the criteria including future maintenance impacts, the following considerations were evaluated and where possible incorporated into the resultant design suggestions:

- Effects and impacts of migratory avian species and timing of access for construction
- Effects and impacts of seasonal fish migration on timing and access for construction
- Effects and impacts of riparian species and how that will impact on construction
- How to minimize impacts caused by necessary access to install piers and abutments
- How to minimize and prevent the generation of siltaceous run off
- How to capture and contain siltaceous runoff and sediment transport materials
- How to allow access for maintenance in future and minimize potential impacts
- Selection of design spans and materials of construction
- Construction techniques that minimize disturbance and accomplish design goals
- Construction equipment service areas that prevent fuel and oil impacts

The result of the process was a design that satisfied the highway transport requirements and served to protect and maintain the Valued Environmental Components (VECs) identified in the study area.

2.4 Impact Analysis

Although the bridge structure conceptual design was prepared to respect the VECs as much as possible, there were inevitable impacts identified both during construction and during the long-term operation and use of the structure. These impacts were identified and assessed in terms of their significance and potential mitigation measures. Residual impacts were identified.

3.0 DESCRIPTION OF STUDY AREA

This section of the report provides a description of the study area in terms of:

- Geology/physiography;
- Hydrology/water quality;
- Vegetation;
- Benthic Invertebrates;
- Fish and Aquatic Habitat;
- Amphibians and Reptiles;
- Birds;
- Mammals;
- Rare or Endangered species;
- Wetland Evaluation;
- Land Use; and
- Archaeological Assess[illegible].

A regional and local context is provided where appropriate and Valued Evironmental Components (VECs) that play an important role in the design of the structure and in the environmental impact evaluation are highlighted throughout the text.

3.1 Geology and Physiography

The study area lies in the physiographic unit called the Antigonish Lowland, bounded by the Pictou Highlands to the west, the Guysborough Highlands to the east and the Southern Upland to the south. St. Georges Bay (of which Antigonish Harbour forms the inner extremity) was originally formed through erosional processes on rocks of the Windsor and Canso Group that underlie this area. Detailed geological mapping from the Nova Scotia Department of Natural Resources (NSDNR) indicated that the Windsor formation underlies the area around Antigonish Harbour while the Canso Group formation underlies areas east of South River. In fact, the contact between these two groups underlies the South River. This was confirmed through the drilling program (see Map No. 1 for borehole locations).

The south portion of the site, near the intersection of South Side Harbour Road, consists of the Canso Group, Hastings Formation. This geology was confirmed in Borehole 1 (BH-1), which was located between the main channel of the South River and South Side Harbour Road.

BH-1 consisted of brown coloured, interbedded river sediments (fluvial deposits) of the South River. Historic channel lag was detected at approximately 3 to 6 metres from surface, and is related to the meandering and continuous formation/change of the South River. A dense silty sand layer was noted between 6 and 8.5 metres from surface and is believed to be an ablation till. Underlying the silty sands red siltstone (mudstone) bedrock was intersected. This bedrock was very severely fractured. The approximate bedding dip was between 20 to 30 degrees to the south, southwest. The regional geology map of the area also notes the bedding dip to be of similar degree and direction. This borehole confirmed the presence of the Hastings Formation Geology, which consists of grey to red siltstone and shale. This formation may also include limestone, but none was detected in BH-1. BH-1 was drilled to a depth of 15.24 metres from surface.

North and west of the South River, Main River channel and BH-1, Windsor Group, Hood Island Formation exists. This geology was confirmed in BH-2, which was located west of the backwater channel of the South River. BH-2 was located approximately 20 metres north of Highway 104.

BH-2 consisted of one metre of flood plain deposits at surface. Beneath the surface soils an ablation till was intersected. These soils consisted of red and grey colour layers of silty sands containing minor sandstone clasts. Limestone bedrock was intersected at approximately 14 metres from surface. The limestone was grey to dark grey in colour and was very severely fractured. This limestone contained a weak petroleum odour when broken for inspection. Natural petroleum is typical of Windsor Group limestone. BH-2 was drilled to a depth of 17 metres in depth from surface.

Figure 2 presents a geological section through the study area based on interpretation of the two boreholes drilled at the site and existing geological mapping. Borehole logs are presented in Appendix D.

Karst topography was not encountered during the intrusive investigation carried out for this assignment. Based on the regional setting, the potential for karst topography is possible, but was not detected in our borehole program. It would be more likely on the west side of the river in the Windsor Group, Hood Island formation. A detailed geotechnical program will be required to better define the geotechnical characteristics of the soils and bedrock in support of detailed design.

3.2 Hydrology

Regional

The study area lies in the lower reaches of the South River Watershed and has an upstream drainage area of approximately 200 km^2. The river flows from its headwaters near Crooked and Stewart Lakes a distance of about 30 km to its discharge to Antigonish Harbour. The watershed area upstream of Highway 104 is illustrated on Figure 1. The watershed is relatively undeveloped, however, it can be accessed throughout its entire length by Highway 316 running south off of Highway 104 at South River Station. Historical hydrologic data for South River was obtained from the Department of Fisheries and Oceans based on a former Water Survey of Canada flow gauging station located at St. Andrews, approximately 5 km upstream of Highway 104. The are no hydraulic structures in the river that restrict flow and the flow can be classified as natural.

The data from the flow gauging station at St. Andrews was prorated (based on watershed area) to provide a reasonable approximation of the flow regime at the study area. The watershed area between the St. Andrews flow gauging station and the 104 is about 25 km^2. Given that the watershed area at the St. Andrews station is 177 km^2, the measured flows may be pro-rated by a factor of 1.14 to get a reasonable approximation of flows at the study area. Figure 3 illustrates the annual hydrograph based on data collected at St. Andrews from 1917 to 1933 and 1965 to 1990 and pro-rated to the 104

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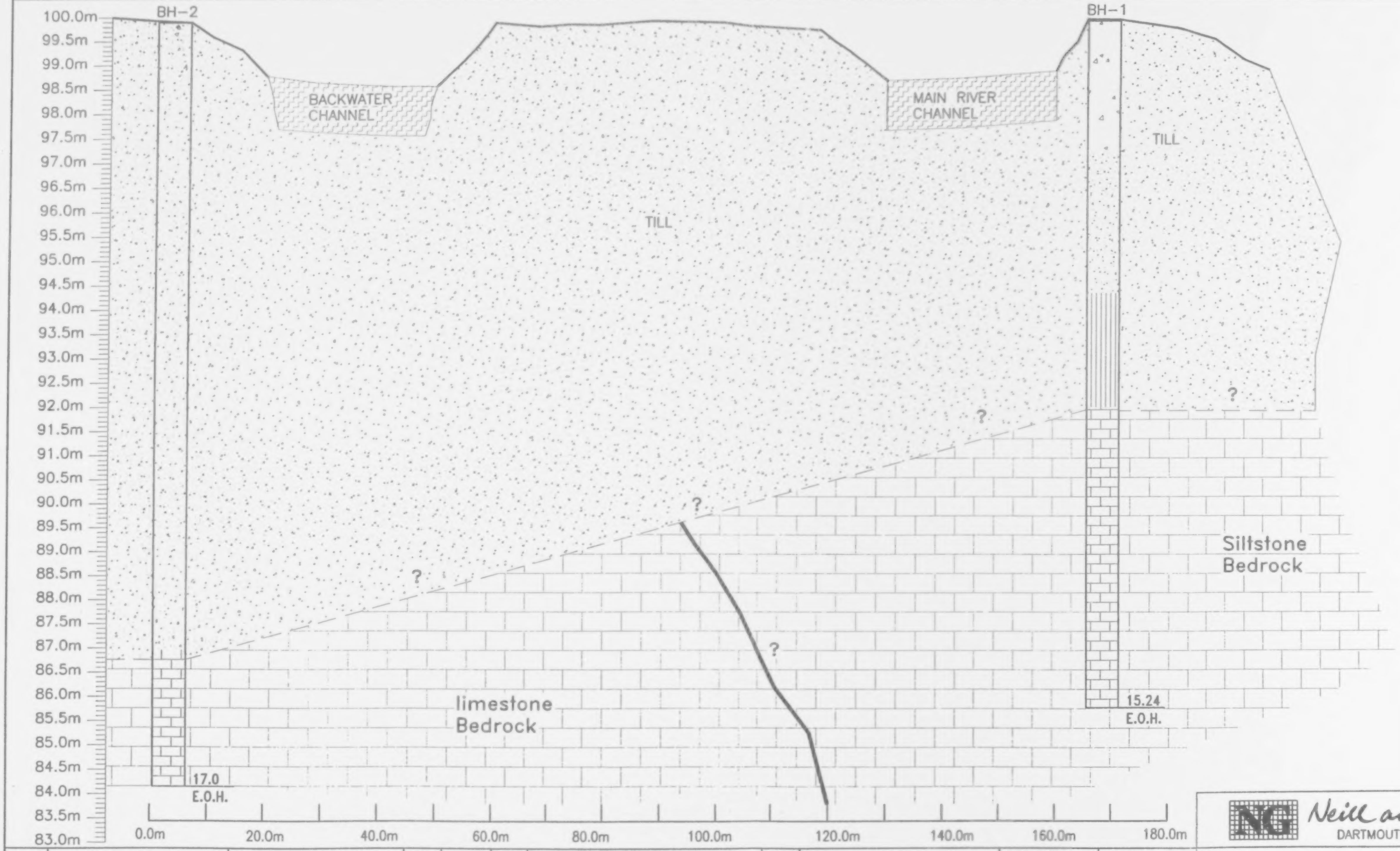

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Neill and Gunter
DARTMOUTH, N.S., CANADA

HIGHWAY 104 ANTGONISH SOUTH RIVER IMPACT STUDY

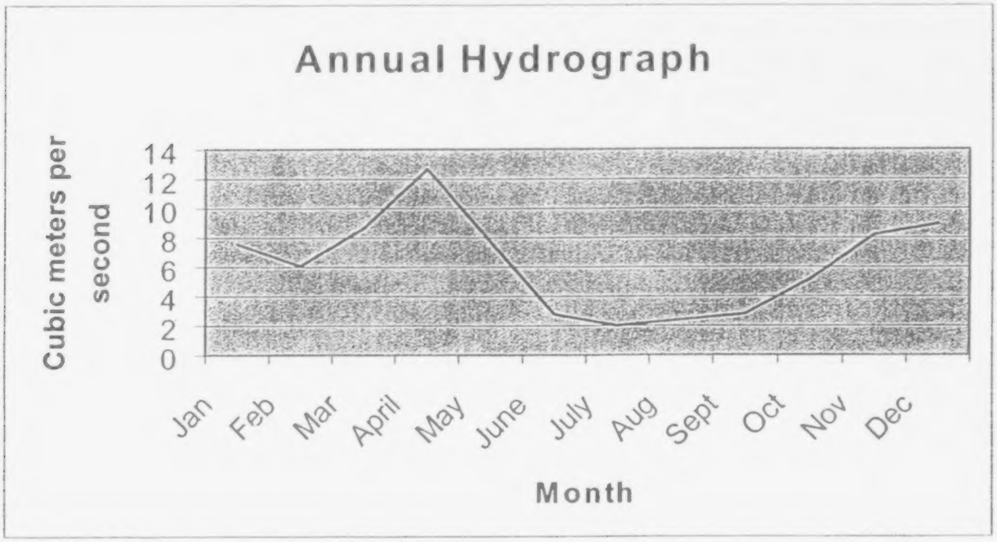
SUBSURFACE PROFILE
MAP-1, SECTION B-B
HIGHWAY 104 ANTIGONISH, NOVA SCOTIA

JOB NO 16053 DWG NO FIGURE-2 REV A

location. The annual hydrograph is typical of a natural flowing river in Nova Scotia with spring peak flows occurring in April and the low (predominantly base flows) occurring in July, August and September.

The study area is located in the lower reaches of the South River watershed. Although not proven through measurements during this investigation, it is typical of the lower portions of the watershed to be regional groundwater discharge areas. Groundwater recharge generally occurs in the upper reaches of the system and tends to discharge through the base of the riverbed in the middle and lower reaches of the system. In this context, one of the hydrologic functions of the wetland area at this location would therefore be ground water discharge. This function will be of particular importance during the summer low flow months when stream flow is almost entirely dependent on ground water discharge.

Figure 3 - South River at Highway 104

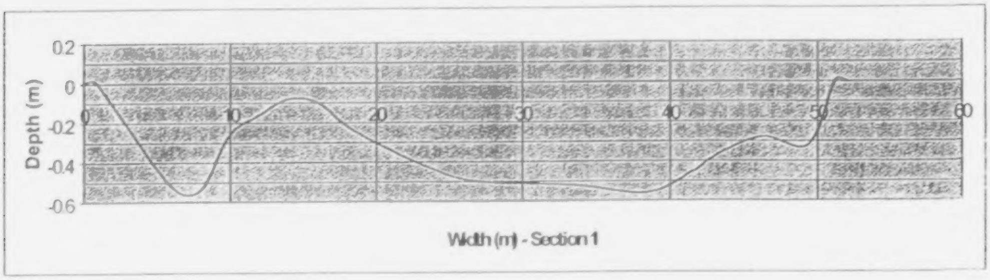


Local

The main channel of the South River at the study area location is approximately 50 m wide. Review of historical photos of the study area and visual observations at the site indicate that prior to construction of the existing Highway 104 and bridge, that the South River flowed through two channels (main channel and back channel) at this location. The back channel was infilled in the course of constructing the existing bridge, causing the entire South River flow to be diverted to the main channel. The original back channel is still in existence downstream of the existing Highway 104 bridge structure, however does not serve a hydraulic function in terms of flow conveyance. The back channel now serves as a "back water" to the main channel.

Two attempts were made to measure flow in the main channel on September 29 and October 4, 2000. On each occasion, water velocities were too low to record a velocity reading on the stream flow equipment used. Moderate northerly winds funnelled up the river valley on both days and contributed to the difficulties in measuring flow. Given the geometry of the river cross section as measured during the field visits and illustrated on Figure 4, average flows for September and October of approximately 2 m^3 per second (see annual hydrograph) would yield velocities of slightly less than 0.1 m/sec. This low velocity approaches the lower limit of the stream gauging equipment used at 0.06 m/sec. It suffices to say that the velocities would be low at this time of year and given the wind conditions on the days of the field visits, stream velocities were not high enough for accurate measurements.

Figure 4 - Section through Main Channel (Water elevation = 0)



The peak flows in South River typically occur in April, with flows reaching 11 m^3 per second (5 times the late summer base flows). Interviews with local residents indicated that the dry land between the main and back channel often floods during the spring high flows. Field observations and discussions with Mr. Partridge (owner of home on the east side of channel) indicated that the typical spring high water mark was estimated to be 0.75 meters higher than the top of bank. At this point in time, the flood plain inundates the dry land or island between the main channel and back channel yielding a flood plain width of approximately 150 meters to accommodate the higher flows. Given the width of the floodplain, stream flow velocities during the spring peak flows are anticipated to be similarly low (less than 0.1 m/sec).

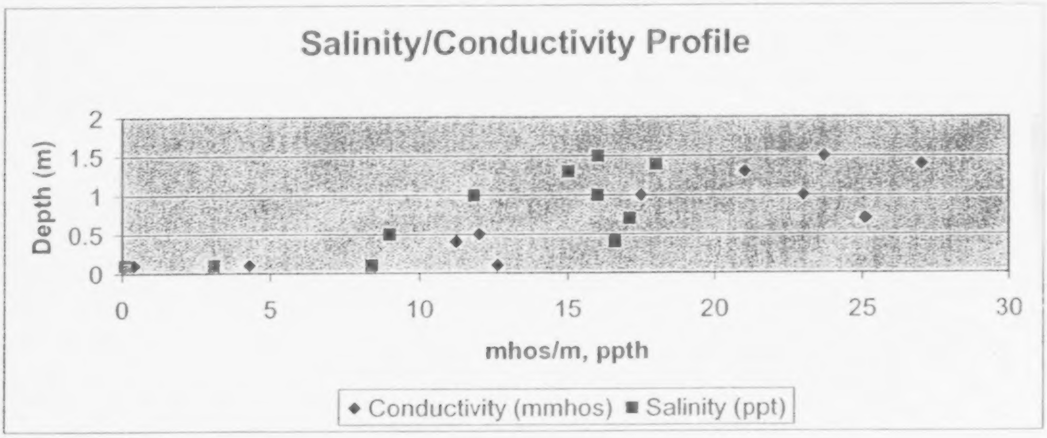
The substrate of the main channel is predominantly gravelly and given the relatively low stream velocities at this location, are not at risk to mobilization throughout the course of the hydrograph.

Water Quality

Salinity, conductivity and temperature measurements were collected at regular intervals across the main channel and back channel sections, at varying depths and at several times during the tidal cycle. The water quality measurements confirmed the estuarine nature of South River at this location. The study area is in a transition zone from a fresh water environment to a salt water environment. Typically, in such situations, the upper portion of the water column is predominantly fresh water and the lower portion of the water column is brackish (mixture of salt water and fresh water).

Salinity measurements ranged from 0.1 parts per thousand (ppt) at the surface to 18 ppt at depths of 1.6 m. Salinity measurements in typical ocean water are in the range of 30 to 35 ppt. Conductivity measurements ranged from 4 millimhos per cm (mmhos/cm) at surface to 28 mmhos/cm at depths of 1.6 m. There were no discernible differences in the salinity profile between locations in the main channel and back channel. Salinity and conductivity data are tabulated in Appendix E. The salinity and conductivity both indicate the water to be brackish with the salt content higher at depth than at the surface. The shallow nature of the channel and the wind conditions on the days of the measurements likely created a significant amount of mixing in this fresh water/salt water interface. As a result, the physical conditions lending to a clear layering of waters that might be found in deeper less agitated estuaries were not present at this location. The data does point to an increase in salinity and conductivity with depth with deeper waters still a mixture of fresh water and salt water (brackish). Figure 5 depicts the results of the salinity and conductivity measurements with depth.

Figure 5 - Salinity/Conductivity Profile at Study Area



The brackish water quality as a result of tidal and fresh water influences is indicative of a fresh water tidal marsh. Other characteristics of a fresh water tidal marsh are described in the following sections of this report.

Important hydrologic characteristics and functions of the study area include:

- Average flow conveyance in the main channel;
- Flood storage and conveyance in the main channel, back channel, and island; and
- Characterised as brackish water indicating an intertidal zone.

3.3 Vegetation

South River is a sub-unit of the Antigonish Uplands. It falls within Loucks' sugar maple-hemlock, pine zone, at the boundary between two ecoregions; a northerly one in which conifers predominate among scattered deciduous stands, and a more southerly one in which shade-tolerant species are found on a wider range of sites. To the west, sugar maple, yellow birch, and American beech are common, with spruce, eastern hemlock, pine, red maple and birch on less well-drained sites. Oldfields regenerating in white spruce are common (Nova Scotia Museum of Natural History, 1997).

The island site at the proposed bridge location is characterized by plant species common to many marsh areas. Five of these plants are salt-tolerant and can be found in brackish water, although none are restricted to such habitats. These include freshwater cord grass, *Spartina pectinata*, bluejoint grass, *Calamagrostis canadensis*, wild rose, *Rosa virginiana*, and the two bulrushes, *Scirpus acutus* and *S. validus* .

The riverbanks site is characterized mainly by mixed/hardwood forest. Vegetation found during the field survey include trees such as balsam poplar, red oak, speckled alder, sugar maple, and white spruce, as well as plants such as Canada goldenrod, chokecherry, coltsfoot, quackgrass, bayberry, orchard grass, and wild carrot.

The general vegetation units (marsh and mixed wood) are indicated on Map No. 1. It is important to note that the vegetation types, particularly in the island and near shore areas are typical of intertidal areas with a mixture of salt and fresh water species.

3.4 Benthic Invertebrates

Benthic invertebrate analysis were carried out on samples collected from seven stations as indicated on Map No. 1.

No benthic species were found in Stations 1 and 2. Stations 3 and 4 had six marine benthic species (*Hydrobia totteni, Nereis diversicolor, Corophium lacustre?, Gammarus tigrinus,* Platyhelminthes, marine oligochaeta) and one freshwater benthic species (chironomidae). Station 5 had four marine benthic species (*Hydrobia totteni, Corophium lacustre?, Gammarus tigrinus,* marine oligochaeta) and three freshwater benthic species (chironomidae, elmidae, trichoptera). Station 6 had two marine benthic species (*Gammarus tigrinus*, marine oligochaeta) and two freshwater benthic species (anisoptera, chironomidae). Station 7 had three marine benthic species (*Corophium lacustre?, Gammarus tigrinus,* marine oligochaeta) and three freshwater benthic species (ceratopogonidae, chironomidae, elmidae).

It is important to note here as well that benthic species are indicative of both salt and fresh water environments that were identified in the study area. This is in keeping with the water quality data and the vegetation units identified earlier.

3.5 Fish and Aquatic Habitat

Fish and aquatic habitat are described in relation to field investigations of the study area and a review of upstream and downstream fish migration in the South River.

Aquatic habitat consists primarily of a main river channel on the east and a backwater channel to the west. Both channels conveyed water prior to construction of the existing Highway 104 bridge. Construction of the bridge blocked the west channel, which has since accumulated a 10 cm layer of organic/silt deposits over an original substrate of medium to fine gravel. Apart from this relatively thin deposition layer, the substrate is consistent throughout the study area, but water depths vary from between 0.3 and 2 m at mean tide. A backwater channel, similar to the west channel, enters the center of the study area's island from the north.

Six minnow traps distributed around the study area caught between 62 and 115 mummichog, *Fundulus heteroclitus*. Fish ranged in size from 3.5 cm to 11 cm. The average size was 5.35 cm. Large numbers of mummichog were also observed in the central island channel during trap collection.

The mummichog is an inhabitant of marshy areas and brackish-water ponds, preferring regions where there is submergent or emergent vegetation (Scott and Scott, 1988). It may live in situations where it is likely to be trapped by tidal movement or by the drying up of small ponds. They are common in estuaries throughout Nova Scotia. Spawning occurs in midsummer.

One white sucker, *Catostomus commersoni*, of length 7 cm was caught in the minnow trap closest to the highway bridge, but not in any other trap.

White suckers are usually fish of warmer, shallow lakes or warm, shallow bays, and tributary rivers of larger lakes. They spawn in the spring, usually from early May to early June (Scott and Crossman 1973).

During salinity profiles and recovery of minnow traps, temperatures ranged from 16 degrees Celcius at the east channel to 20 degrees Celcius at the middle bay. Conductivity ranged from 0.4 at the main channel at the bridge to 27 at the outer west channel. Salinity ranged from 0.1 at the main channel at the bridge to 18 at the outer west channel.

Overall, the study area appeared to be equally productive for fish in the main and side channels. The area does not likely provide spawning habitat for any species, but the large numbers of mummichog undoubtedly provide an important source of food for other fish and birds.

Fish Migrations

A counting fence was operated between 1983 and 1987 on the South River, approximately one km upstream of the TransCanada Highway where tidal influence is minimal. Movements of Atlantic salmon, *Salmo salar*, brook trout, *Salvelinus fontinalis*, rainbow trout, *Salmo gairdnerii*, brown trout, *Salmo trutta*, gaspereau, *Alosa pseudoharengus*, rainbow smelt, *Osmerus mordax*, white perch, *Morone americana*, yellow perch, *Perca flavescens*, white sucker, and American eel, *Anguilla rostrata*, were monitored through a two-way fish fence from May to November. Table 1 shows the time and direction of fish movement in South River during these years. Only results for prevalent fish species are given.

Table 1: Upstream and Downstream Movements of Major Fish Species at the South River Counting Fence, 1983-87.

Date	Atlantic Salmon	Brook Trout	Rainbow Trout	Brown Trout	Gaspereau	Smelt
May	Downstream	Downstream Upstream	Downstream Upstream	Downstream Upstream	Downstream Upstream	Downstream Upstream
June	Downstream	Downstream Upstream	Downstream Upstream	Downstream Upstream	Downstream Upstream	Downstream Upstream
Jul 1-15	Downstream	Downstream Upstream	Downstream Upstream		Downstream Upstream	
Jul 16-31					Downstream	
Aug 1-15						
Aug 16-31						
Sep 1-15						
Sep 16-30						
Oct 1– 15	Upstream					
Oct 16–31	Upstream			Downstream		
November	Upstream					

Atlantic Salmon move up rivers in order to spawn from spring through fall. Spawning occurs during October and November usually in gravel-bottom at the head of riffles or tail of a pool. After about 3 years in fresh water, salmon parr turn into smolts and prepare for life in saltwater. During the spring run-off, smolts form schools and migrate downstream at night. In South River, the majority of salmon smolts migrated downstream in May, with low numbers continuing in June and early July. Upstream migration in October was primarily large salmon.

In 1997, anglers only reported a total of 4 salmon on South River in comparison with 46 in 1996. The low number for 1997 is not unusual for the South River where catch reports are often just a handful of fish; the 1987-96 average total catch for the river was 11 fish as a result of a number of years when no fish were angled (DFO, 1998).

Brook trout usually move downstream to the sea in spring in order to feed and return to freshwater streams in July and August. Spawning takes place in late summer or fall. Not all brook trout in a population will go to sea, some may choose to remain in fresh water (Scott and Scott, 1988). In South River, major upstream and downstream movements occurred concurrently during May, June and early July.

Rainbow trout spawn from March to May in small tributaries of rivers, or in inlets or outlets of lakes. Spawning can also take place in late fall or early winter (NS Department of Fisheries and Aquaculture, 2000). Rainbow trout are not native to South River. They are released annually from the hatchery on the river for recreational purposes. Major upstream and downstream movements of rainbow trout occurred concurrently during May, June and early July.

Brown trout is an introduced species in Atlantic Canada. Some migrate to sea (sea trout) and return to fresh water in the fall. Spawning takes place in late fall or early winter (Scott and Scott, 1988). Apart from moving upstream to spawn, adults tend to stay at the same place in a river with very little movement to other stream areas. Others move to or from estuaries in the spring or fall. In South River, major upstream and downstream movements of brown trout occurred concurrently during May and June. Another downstream movement by brown trout occurred in late October. Sea trout movements through the study area peak in June (Charles MacGinnis, *pers. comm.*).

Rainbow smelt are anadromous and move into estuaries in the fall and to streams after the spring thaw. Spawning occurs from February to June at night in fast moving water (NS Department of Fisheries and Aquaculture, 2000). In South River, major upstream and downstream movements of smelt occurred concurrently during May and June.

Gaspereau are an anadromous species living most of its adult life at sea, entering fresh water only to spawn. Spawning takes place in the spring in lakes, ponds, rivers, and streams above the head of tide. They may also live throughout their lives in fresh water, when they are referred to as 'landlocked' (Scott and Scott 1988). Gaspereau began to arrive upstream in South River during mid-May and stayed for only a few weeks before migrating downstream. Population numbers of gaspereau reached thousands downstream by late June and movement continued at lower levels throughout July. Gaspereau in South River are usually quite active in June and July (Charles MacGinnis, DFO Antigonish, *pers. comm.*).

Low numbers of white perch, yellow perch, white sucker, and American eel were also counted from 1983 to 1987. White perch is an anadromous species but is mainly restricted to freshwater lakes and rivers. Yellow perch are generally found into the lakes, but often move into tributary rivers to spawn. White sucker are widespread in Nova Scotia, but are restricted to freshwater habitats.

American eels leave the sea, enter fresh water early in development, and remain there throughout life, returning to the sea to spawn and presumably die (Scott and Scott, 1988). In South River, upstream movement occurred in July, August, and September, however, the maximum number of eels trapped in any year was only 2. Eels were travelling downstream from May to July and from September to November.

American shad may also be found in South River (Charles MacInnis *pers. comm.*). American shad migrate from the sea into coastal rivers in spring to spawn. Spawning normally occurs in May, June, or even July (Scott and Scott 1988). Fourspine stickleback, *Apeltes quadracus*, and Atlantic silversides, *Menidia menidia*, might also be found in South River. These fish are found in many lakes and streams throughout Nova Scotia. Atlantic silversides are found in West River, Pictou County.

Important characteristics and functions identified through the fish and aquatic habitat analysis included:

- The main channel and back channel areas are equally productive in terms of fish habitat;
- The area supports a relatively high quality recreational fishery for game species like brook trout, brown trout and Atlantic Salmon; and
- The primary function for game species is fish passage (spawning habitat is not present for these species).

3.6 Amphibians and Reptiles

The study area is not particularly important for amphibians and reptiles, but wood turtle, snakes, salamanders and frogs occur in the area. Wood turtle, *Clemmys insculpta*, habitat surrounds the study area. Snapping turtles, *Chelydra serpentina serpentina* are generally found south of the St. Mary's River, but at least one specimen has been observed near the study area (Mr. Pulsiver, *pers. comm.*). No uncommon snakes are known to occur in the area.

Yellow-spotted salamanders, *Ambystoma maculatum*, and blue-spotted salamanders, *Ambystoma laterale*, are common at South River. Eastern redback salamanders, *Plethodon cinereus*, may be found in the forest. There is no sphagnum to provide sufficient habitat for four-toed salamanders, *Hemidactylium scultatum*.

The northern leopard frog, *Rana pipiens*, and pickerel frog, *Rana palustris*, may occur along the river sides but in general, amphibians don't like salt water.

3.7 Birds

The bird survey was done in the late season on a date very much after most breeding birds had left. Therefore, it was too late to confirm breeding of any species. The eleven species seen on that date represent a small portion of the avifauna of the study site.

Bird species seen on 14 October, 2000 were great blue heron, *Ardea herodias*, American black duck, *Anas rubripes*, green-winged teal, *Anas crecca*, common merganser, *Mergus merganser*, herring gull, *Larus argentatus*, rock dove, *Columba livia*, American crow, *Corvus brachyrhychos*, black-capped chickadee, *Poecile atricapilla*, golden-crowned kinglet, *Regulus satrapa*, European starling, *Sturnus vulgaris*, and red-winged blackbird, *Agelaius phoeniceus*. All but the great blue heron and the golden-crowned kinglet are listed as confirmed breeding birds by Erskine (1992) in the 10 km square in which the study site is located.

Bird species previously recorded using the study area by Randy Lauff and that have confirmed breeding bird status by Erskine (1992) include the pied-billed grebe, *Podilymbus podiceps*, mallard, *Anas platyrhychos*, osprey, *Pandion haliaetus*, bald eagle, *Haliaeetus leucocephalus*, red-tailed hawk, *Buteo jamaicensis*, belted kingfisher, *Ceryle alcyon*, blue jay, *Cyanocitta cristata*, common raven, *Corvus corax*, American robin, *Turdus migratorius*, cedar waxwing, *Bombycilla cedrorum*, common yellowthroat, *Geothlypis trichas*, Nelson's sharp-tailed sparrow, *Ammodramus nelsoni*, song sparrow, *Melospiza melodia*, swamp sparrow, *Melospiza georgiana*, common grackle, *Quiscalus quiscula*, and American goldfinch, Carduelis tristis.

Bird species previously recorded using the study area by Randy Lauff but not listed as confirmed breeders by Erskine (1992) include rose-breasted grosbeak, *Pheucticus ludovicianus*, rusty blackbird, *Euphagus carolinus*, wood duck, *Aix sponsa*, black-headed gull, *Larus ridibundus*, ring-billed gull, *Larus delawarensis*, and yellow-rumped warbler, *Dendroica coronata*.

The area immediately to the west and to the south of the proposed bridge location is classified by the Canadian Land Inventory (CLI) as having moderately severe limitations to the production of waterfowl. Limitations are due to adverse topography; either steepness or flatness of the land may limit the development of permanency of wetlands, and landform; poor distribution or interspersion of marshes or basins may be a limiting factor of the land and may prevent the development of optimum waterfowl habitat.

To the north of the study area is Antigonish Harbour, which has been classified by CLI as being an important migration or wintering area for waterfowl, although they may not be useful to waterfowl production. Lands immediately to the west and east of Antigonish Harbour have severe limitations in which almost no waterfowl are produced. Limitations to the west are due to adverse topography whereas limitations to the east are due to adverse topography, landform, as well as inundation in which the limiting factor is excessive water level fluctuation or tidal action, which adversely affects the habitat or the nesting success of waterfowl.

Salinity and tidal action keep coastal waters open later in fall and earlier in spring than most freshwater areas. Generally, the areas most frequented by waterfowl and other aquatic birds – the shallow, sheltered waters and adjacent shores – are the first to become ice-bound and the last to open (Nova Scotia Museum of Natural History 1997).

The marsh at Lower South River acts as a thoroughfare for brood-rearing waterfowl such as American black ducks. In addition, green-winged teals likely breed here. Perhaps most importantly, the area is a small migratory stopover site for ducks in both spring and autumn. In particular, the spring migration at this site hosts many wood ducks, a species which never returned to numbers seen prior to hunting becoming regulated.

Staging of migratory dabbling ducks, especially black ducks and the teals, mostly occurs in salt marshes and adjacent open-water areas. Green-winged teals depart in October, but many black ducks remain all winter, withdrawing to the southwest as other areas are closed to them.

Two bald eagle nests are within two kilometres of the study site. The adults forage at the study site throughout the nesting season (April – August) and throughout the rest of the year as long as the river is not frozen. The study site also provides many snags and live trees that osprey can use as hunting perches.

3.8 Mammals

The Northumberland Strait is an excellent area for coyote, muskrat, beaver, mink, fox and raccoon. Squirrels, rabbits, fox, deer and bear have also been found in the area. There are undoubtedly numerous other mammals in the area, particularly rodents, insectivores, and mustelids (NS Museum of Natural History, 1997).

South River is a sub-unit of Antigonish Uplands. The Antigonish Uplands provides mainly forested habitats, with cliffs along St. Georges Bay. Information on small mammals is lacking, but diversity is thought to be moderately high (NS Museum of Natural History, 1997).

The Canada Land Inventory classifies South River as an area of high capability with lands that have very slight limitations to the production of ungulates. Slight limitations are due to excessive soil moisture.

3.9 Rare or Endangered Species

Rare animals are those non-introduced or non-domesticated species which occur in only a few localities in the province and/or are represented by relatively few individuals (NS Museum of Natural History 1997). No authoritative list has yet been published of the animals considered to be rare in Nova Scotia. COSEWIC has assigned status (endangered, threatened, vulnerable) to a portion of our plant and animal species.

No plants listed by COSEWIC or by the Nova Scotia Endangered Species Act were found at the study site, however the ground-nut, found at the island site, was a new record for Antigonish County. This should not be a problem since it is common further west in Nova Scotia and in Canada.

No fish listed by COSEWIC or by the Nova Scotia Endangered Species Act were found at the study site, however, Atlantic salmon and brook trout are protected by seasons and/or by bag limits under the Fisheries Act. In 2000, sport fishing in South River, downstream from the bridge that marks the outlet of Lock Katrine (South River Lake), began on April 15th, unlike the common date of April 1st that occurred throughout most of the province. The delay was set in order to protect Atlantic salmon and sea-run trout stocks in the area that are particularly vulnerable at that time of year.

Due to overfishing and the destruction of habitat, salmon no longer can be found in much of its original range and the numbers of fish have seriously declined (NS Department of Fisheries and Aquaculture, 2000). The salmon fishing season has therefore been restricted to September and October and only catch and release is allowed.

Many populations of brook trout in Nova Scotia have declined. They are vulnerable to overfishing and human practices that affect their habitat (Nova Scotia Department of Fisheries and Aquaculture, 2000). In September, anglers were reminded to catch-and-release brook trout, and restrict the use of bait when angling in freshwater for brook trout, brown trout, rainbow trout and landlocked salmon. Brook trout are particularly vulnerable to angling in September when they school near the mouths of streams prior to spawning. In October, no brook trout can be retained.

There are no threatened or endangered herpetile species at or surrounding the study area.

Erskine lists the common loon, *Gavia immer*, common tern, *Sterna hirundo*, arctic tern, *Sterna paradisaea*, and piping plover, *Charadrius melodus* as having confirmed breeding status in the 10 km square in which the study area is located (Appendix B). The common loon, common term, and arctic tern have been given yellow (cautionary) status by NSDNR and the piping plover has been listed as endangered by Canadian Species at Risk (COSEWIC). Although listed as confirmed breeding birds, none have been reported breeding within the study area, and the site does not provide sufficient breeding habitat. Common loons mainly breed on islands within freshwater lakes, common and arctic terns breed very close to open bodies of water, mainly on beaches of coastal islands, and piping plovers breed on sandy beaches. Nelson's sharp-tailed sparrow likely breeds at or near the study site. Singing males have been heard which is an indicative of at least a desire to nest. This species has been given yellow (cautionary) status by the Nova Scotia Department of Natural Resources (NSDNR). Nelson's sharp-tailed sparrow usually arrives in numbers during the first two weeks of June and last sightings are usually in October (Tufts, 1986).

3.10 Coastal Freshwater Marsh

The study area can be classified as coastal freshwater marsh. Coastal freshwater marshes are marine intertidal areas with soft substrate, colonized predominantly by grasses. They occur only where there is regular flooding and nearby sources of fine sediment. They are widely distributed in small areas all around the province, especially associated with salt marshes, and form when the effect of salt water on the low-lying coast is moderated by freshwater runoff. Where this occurs, the salt-tolerant plants of the intertidal zone give way to non-tolerant species (Nova Scotia Museum of Natural History, 1997)

Coastal fresh marshes are highly productive systems with abundant nutrients. The primary production is largely carried out by grasses, sedges and rushes, and is either consumed or accumulates on site, adding organic material to the soil. Consumers on site include insects, waterfowl and small mammals.

The aquatic fauna in coastal fresh marshes is generally poor, being restricted to insects and their larvae – water boatmen (Corixidae), flies and mosquitoes and succineid snails. The bird and mammal life is important, particularly waterfowl, muskrat, raccoon, mink and small mammals. The Northern Harrier nests on the ground in this habitat. Erskine (1992) lists the Northern Harrier as being a probably breeder in 10 km square in which the study site is located.

3.11 Uses of the Area

Recreation

The Canadian Land Inventory defines South River as having lands in which there is moderately low to low capability for outdoor recreation. These lands can provide and sustain moderately low total annual use based on dispersed activities.

Positive aspects of the land at or surrounding the study area include frequent small water bodies or continuous streams occurring in upland areas; water affording an opportunity for angling or viewing of sport fish; landscape patterns of agricultural, industrial, or social interest; interesting rock formations; a variety, in topography or land and water relationships, which enhances opportunities for general outdoor recreation such as hiking and nature study or for aesthetic appreciation of the area; and a vantage point or area which offers a superior view, or a corridor or other area which provides frequent viewing opportunities (Canada Land Inventory).

Fishing is the major recreational activity within the study area. The recreational fishing season in 2000 for South River for species other than Atlantic salmon, downstream from the bridge that marks the outlet of Lock Katrine (South River Lake), was from April 15th to October 15th.

April is the most popular month for sport fishing at which time anglers are seen lining the riverbed at the existing bridge and at the trestle downstream from the study site (Charles MacInnis *pers. comm.*). During this time, brook trout, rainbow trout, brown trout, gaspereau, and smelt are highly active travelling both upstream and downstream. In June, angling effort is focused on searun brown trout, which move up and down the river (Charles MacInnis *pers. comm.*). Striped bass are fished primarily from the railway trestle downstream of the study area.

Throughout July, August, and early September, little angling occurs at the existing bridge. The salmon fishing season is from September 1st to October 31st, but anglers mainly begin to fish for salmon in October (Charles MacInnis *pers. comm.*).

Land Use

Coastal areas of the Northumberland Plain had traditionally been the summer camps of the Mi'kmaq. Settlers of largely English and Scottish descent cleared much of the land for agriculture, which continues to be an important economic activity. Farming, forestry, and fishing also serve as the economic base for most communities here.

Logging and small farming in valley intervales characterize much of the land use in the Antigonish Uplands. In the South River area, limestone is quarried at Antigonish. The Fraser Mills Fish Hatchery raises small fish for lake stocking programs throughout the province and an exhibition centre at the operation provides information on the hatchery and local angling.

In terms of agriculture, soils at and surrounding the study area are defined by CLI as having moderately severe limitations that restrict the range of crops, require special conservation practices, or both. Flooding by streams and steepness or patterns of slopes or lakes limit agriculture use. Soil limitations may be due to either low permeability, a restricted rooting zone because of soil characteristics, low natural fertility, low moisture-holding capacity, or salinity.

3.12 Archaeological Investigation

Much of the land on the western side of the river within the development area has been disturbed by recent plowing as well as by erosion resulting from the river's action. Although the eastern area was once the site of much cultural activity, little evidence of that activity remains. Previous construction has resulted in the destruction of many of the nineteenth century buildings that were located here. The only observed remnant of past features is an 1853 bridge footing which has, for the most part, been destroyed by previous construction and/or the tidal action of the river. Due to the recent age of the feature in question as well as the impact it has been subjected to by past construction activities, it is of low archaeological significance.

The area (intersection of existing Highway 104 and driveway for Partridge residence) in which the nineteenth century carriage house was located is of concern since it is located within the study area. There have been high levels of modification to this area by way of construction of nearby houses and associated landscaping as well as by construction of the Trans-Canada Highway. It is possible that evidence of this structure remains beneath the existing highway and will be impacted by construction.

Although the cemetery to the north of the study area as well as the early nineteenth century house to the west are located outside the study area, they are of high archaeological significance.

The entire report an Archaeological Resources is contained in Appendix F.

4.0 WETLAND EVALUATION

The Wetland Evaluation Guide (Bond et al., 1992) provides a comprehensive methodology for reviewing potential impacts on wetlands based on a project's effect on functions. Functions are divided in those providing life support, social-cultural uses, and resource production. The evaluation compares effects on functions compared to project benefits. Functions viewed as particularly important are identified as critical values, and are summarized at the end of this section. Detailed information on the wetland evaluation process in the tables provided in Appendix F.

The Regional Context

In terms of evaluating the regional significance of the South River Coastal Freshwater Marsh area, it is helpful to consider it in terms of other coastal wetlands/marshes in the region. Two such areas include Pictou Harbour Estuary and Pomquet Harbour. Pictou Harbour is approximately 100 km to the west of the study area, and Pomquet Harbour is eight kilometres to the east.

Pictou Harbour

Pictou Harbour Estuary is in a lowland area bordering the Northumberland Strait and abutting the Pictou-Antigonish Highlands. Recreational fishing for trout and salmon is popular and the East River has an important salmon run. Mackerel, eels, smelt, and gaspereau are fished commercially in the estuary and recreational fisheries for mussels and oysters occur. Boating and sailing are popular, and the harbour supports a yacht club and a marina. High-use beaches are along the Northumberland Strait Shore.

The Pictou Estuary is also a migratory bird staging area and is locally important for ducks and geese. Open water in winter at the Pictou causeway and in the East River at the mouth of Lowden's Brook attracts a variety of migratory waterfowl including black ducks, goldeneye and mergansers. A breeding colony of double-crested cormorants occurs next to the causeway, and bald eagles and osprey nest and feed in the area. Lighthouse Beach is known to have supported breeding piping plover.

Pomquet Area

Perhaps the wetland with the greatest value within the Northumberland Plain region is *Pomquet Beach*. Pomquet Beach is located at the southwestern corner of St. George's Bay and consists of a numerous series of parallel dune ridges forming a very wide, barrier beach across Pomquet Harbour. Pomquet Beach has a complete dune succession from beach to forest (Dalhousie University, undated). The Grey dune grades gradually into an open grassland community in the eastern half of the system. The grassland in the east and grey dune in the west merge into a belt of heath shrubs and scrub forest which separates them from the main forest. The rare bastard toadflax is common in the heath area, its only known location in mainland Nova Scotia.

The Pomquet area salt marsh is narrow at the east becoming progressively wider along the harbour channel and then expanding at the eastend in the lagoon area. There are numerous zones of vegetation in this marsh, the most noticeable of which are a cord grass community, a *Spartina patens* community, and an upper band of rushes. The frequent flats are dominated by arrow grass and sea milkwort.

The rich and varied habitat contains a wealth of wildlife. There are at least 8 species of warblers, 4 species of sparrows, 3 species of thrush, several species of flycatchers and several other songbirds breeding in the area. Common and roseate terns, willets, semi-palmated plovers and spotted sandpipers breed in the salt marsh and lagoon area. Blue heron, ospreys and marsh hawks are commonly seen and presumably breed nearby. The freshwater swamps support populations of breeding black and blue-winged teal ducks. Saw-whet, barred and great-horned owls also occur in the area. Squirrels, rabbits, fox, deer and bear have been found at Pomquet Beach. There are presumably numerous other mammals in the area particularly rodents, insectivores, and mustelids.

South River Coastal Freshwater Marsh

The South River Coastal Freshwater Marsh is typical of the estuarine environments in the Georges Bay area. In comparison to other coastal features, for example the Pomquet Beach Marsh is more unique and sensitive with its sand dune structures. Although, the South River Coastal Freshwater Marsh is not rare or unique in a regional context, it does provide important local habitat, hydrologic and social/cultural functions as described in the detailed wetland evaluation.

4.1 Life-Support Functions

Life-support considerations include hydrological, biogeochemical, habitat, and ecological functions. Hydrological functions examine the function of the wetland primarily in relation to its effect on downstream flows. The study area is located at the lower end of the watershed, minimizing its role in flood reduction. It has a role in reducing tidal effects in upstream areas, but the influence of tidal effects is relatively small. The marsh does contribute to usable surface water but it is a small proportion of the saltwater wetlands in Antigonish Harbour. All hydrological functions are relevant at the local levels.

The study area is typical of the freshwater saltwater interface in most estuaries of the province, but nonetheless, the mix of salt and fresh water is relatively uncommon aquatic habitat. The intrusion and mixing of the heavier salt water provides nutrients that support high levels of production, notably in forage fish species, such as mummichogs. In terms of biogeochemical function the study area has high nutrient levels which support significant wildlife populations at a regional level. As a result, it is an important feeding area for various bird and fish species, however, larger populations of migratory birds and a greater diversity of fish species exist seaward (downstream) of the study area. It may also be possible that the marsh provides storage for agricultural run-off since there is a field nearby. In terms of wildlife habitat, the marsh contains high quality significant habitat for migratory birds as well as habitat for sport and/or commercial fish. The marsh provides a feeding area for migratory birds and may also serve as a breeding ground for some species such as green-winged teal. The marsh also acts as a critical migration route for several important recreational fish species such as Atlantic salmon and brook trout.

More significant bird habitats within the Northumberland Plain are located around Fox Harbour, Wallace Harbour, Tatamagouche Bay, Brule Harbour, and John Bay, where large numbers of ducks and geese congregate in late March and early April, and again in September until ice forms in December. Other important areas include Coldspring Head and the mouth of the Shinimicas River, Pugwash Harbour, River Philip, West

River; Little Harbour and Merigomish Harbour (NS Museum of Natural History, 1997). Important wildlife management areas within the Northumberland Plain region include: Wallace in Cumberland County, Abercrombie in Pictou County and the Brule Point Game Sanctuary in Colchester County. Rare or vulnerable animal or plant species may occur in or near the study area. Nelson's sharp-tailed sparrow likely breeds in the area and has been given cautionary status by the Nova Scotia Endangered Species Act. Wood turtles, are listed as vulnerable by COSEWIC, have been seen near the area (Mark Pulsifer, NS Natural Resources, *pers. comm.*). Plant species listed as rare in Roland and Smith (1969) have also been found near the study area (Barry Taylor, St. Francis Xavier University, *pers. comm.*). These include blue vervain, *Verbena hastata*, bluegrass, *Poa alsodes* and feverwort, *Triosteum aurantiacum*. It is also possible that the marsh provides significant habitat for crustaceans and mammals, and may also help to protect natural shorelines. The study area also has a high biological diversity, but still probably lower than many other parts of Antigonish Harbour where true salt marsh exists.

4.2 Social/Cultural Values

Social/Cultural functions considered include aesthetics, recreational, education and public awareness, public status, and cultural attributes. The study area is visible from Highway 104, a provincial highway. The marsh provides a valuable aesthetic or open space function that adds to the visual diversity of the landscape. The view is not unique in the region, however, and other nearby views are of equal of greater value. The study area also provides opportunities for recreation, such as canoeing and high quality sport fishing. Recreational fishing could be disturbed by construction, but a relatively large window exists during the summer when little or no activity occurs. The marsh may also provide a base for viewing or photographing wildlife, such as migratory birds, but access to the area will remain largely unchanged.

The study area is close to Antigonish, a relatively large urban population providing potential roles in education and public awareness.

The marsh forms part of the historical/cultural heritage of the region because it rivers and estuaries have all been important areas to First Nationals and early settlers. The study area may also provide traditional use, such as fishing for food or ceremonial purposes, for aboriginal peoples.

4.3 Wetland Production Values

Wetland production functions considered include agriculture, renewable and non-renewable resource extraction, tourism and recreation, and urban values.

Agricultural, non-renewable resource, and urban use of the study area has not been identified. The study area provides opportunities for non-commercial uses of fish, wildlife, and/or water resources primarily through sport fishing. The marsh also has the potential to be used for commercial or subsistence hunting, trapping and fishing by aboriginal peoples. Recreational fishing in the area is the primary tourism and recreation use of the study area. The large number of anglers suggests a regional importance, and purchase of equipment, services, food and accommodations no doubt provides benefits to the regional economy.

4.4 Project Benefits

Project benefits considered include employment, economic, production, and urban/industrial infrastructure development benefits. Employment benefits will result from the stimulation of new employment opportunities or stabilization of existing employment levels in the region. The role of the project in stimulating job benefits is low because the project is short-term. Possible economic and production benefits may result from improved transportation into and through the area. The road will improve a major transportation link in the region, generally improving the urban/industrial infrastructure. Alternative routes for the highway would probably have similar benefits.

4.5 Summary of Critical Values

In the wetland evaluation process, some issues and functions are considered more important than others, and are identified as critical values marked by an asterisk (*) in the detailed tables in Appendix G. Critical value notation indicates a wetland value whose product, service, or function is very important to society or where an important threshold or function may be exceeded, resulting in the loss of the function and value (Bond et al., 1992). A total of five critical values were identified in the wetland analysis of potential impacts on functions (Table 2).

Table 2: Summary of Wetland Significance and Expected Impact.

	Number of Critical Values	Level Criterion	Expected Impact
		N, P, R, L, NE	H, M, L
LIFE-SUPPORT VALUES			
Hydrological Values	2	L	L
Biogeochemical Values			
Habitat Values	1	R	L
Ecological Values	1	L	L
SOCIAL/CULTURAL VALUES			
Aesthetic Values			
Recreational Values			
Education and Public Awareness Values			
Cultural Attribute Values			
PRODUCTION VALUES			
Agricultural Values			
Renewable Resource Values			
Non-renewable Resource Values			

	Number of Critical Values	Level Criterion	Expected Impact
Tourism & Recreational Values	1	R	L
Urban Values			
TOTAL OCCURRENCES	5		

Legend
N = National
P = Provincial
R = Regional
L = Local
NE = Negligible
H = High
M = Moderate
L = Low

Two critical values were noted under hydrological values because the marsh provides flood protection benefits and serves to reduce tidal impact. Only minor displacement of flood and tidal water occurs, therefore expected impact due to bridge construction is low.

One critical value was listed under habitat values since the marsh contains high quality significant habitat for migratory birds. Expected impact from bridge construction is again low because there is more suitable habitat for migratory birds further downstream and within Antigonish Harbour.

One critical value was listed under the ecological values section of the wetland analysis. Due to a mixing of salt and freshwater, there is an increase of biological diversity in the marsh. Again, areas further downstream and within Antigonish Harbour are considered more important and impact of bridge construction within the study area is expected to be negligible.

One critical value was also designated under tourism and recreational values. The marsh represents an important regional tourism and recreation attraction due to the sports fishery. Expected impact would be low as long as construction avoids the period of angling activity.

Table 3 provides a summary of the project benefits.

Table 3: Summary of Project Benefit Significance and Expected Impact.

	Number of Critical Values	Level Criterion	Expected Impact
		N, P, R, L, NE	H, M, L
Employment Benefits	1	R	L
Economic Benefits			
Production Benefits			
Urban Development Benefits			
TOTAL OCCURRENCES			
***Critical Value Totals**	1		

Only employment benefits were considered to represent a critical value. Construction of the bridge will provide new employment opportunities or stabilize existing employment levels in the region; however, the magnitude of the employment stimulation is expected to be low and temporary.

5.0 VALUED ENVIRONMENTAL COMPONENTS

The assessment of the study area detailed in the previous sections identified a number of Valued Environmental Components (VECs) for the study area. These are summarized in the following table.

Table 4: Valued Environmental Components

VEC	Function and Level of Importance
Recreational Fishery	The South River supports a thriving recreational fishery for a number of game species including trout and Atlantic salmon. Although the study area does not provide critical breeding habitat for these species, it is important for fish passage and to a lesser degree, rearing habitat. It was reported that the banks of the river at the study area are often lined with people in the fall during the recreational salmon fishery. It is important that the main channel in particular maintain its function in providing fish passage and continued opportunities for recreational fishing.
Terrestrial Habitat	The marsh area supports a variety of species.
Migratory Birds	The general area is known to provide a staging area for migratory birds. Although not documented in the exact study area, migratory birds are known to utilize the habitat provided in the South River area nearer to Georges Bay.
Flood Storage	The land between the main channel and the back channel serves a significant flood storage function during the spring peak flows in South River. Any infilling in the flood plain will displace a volume that would otherwise provide flood storage. Displacement should be minimized.
Nature Viewing	The South River Coastal Freshwater Marsh provides opportunities for wildlife viewing in the local area. Its proximity to the Town of Antigonish and sight lines from Highway 104 and South Station Road make wildlife viewing a valued local use.
Rare and Endangered Species	No rare or endangered species have been observed within the study area although the sharp-tailed sparrow has been heard in the vicinity.

6.0 CONCEPTUAL DESIGN

6.1 Guiding Design Principles for Environmental Protection

Based on the VECs identified above and in order to provide a conceptual design that respects the environmental features and functions of the study area, the following design principles were adopted:

- The bridge structure and foundations should avoid displacing aquatic habitat in both the main and back channel portions. It is preferable to span these watercourses in an effort to maintain the fish passage and rearing functions.

- Of the two watercourses, the main channel is more sensitive to disturbance than the back channel because it provides for both fish passage and rearing while the back channel area provides for rearing habitat only. In addition, the main channel is more complex because of its hydraulic functions in water conveyance whereas the back channel does not provide this function.

- The structure should try to avoid filling in the flood plain in order to maintain the flood storage function of the area as well as to minimize displacement of terrestrial habitat.

- It is desirable to align the structure to minimize the total area of terrestrial habitat maintained beneath the structure. This means aligning the structure at the narrowest portion of the ROW.

- In terms of noise and vibration impacts additional to the existing bridge, would be desirable to locate the new structure in close proximity to the existing structure (within the existing impacted area) in order to minimize the total additional area impacted.

- Discussions were held with representatives of the NSTPW regarding span lengths and cost implications for bridges in Nova Scotia. It was decided that a maximum span length of 60 meters was preferable.

6.2 Proposed Layout and Design

A four-span steel girder structural system with a concrete deck is proposed. The use of weathering steel has some advantages in terms of foundation loading where karst conditions are possible and provides a relatively maintenance free structural system. The proposed layout is depicted in plan and sections on Drawing No. G-301, Sheets 1 and 2.

The major elements of the structure consist of the following:

- Four 60 m spans of weathered steel
- Abutments at the east and west ends of the structure
- Piers and abutments founded on piles
- Concrete deck
- Jersey barrier style guard rails

Given the consistency of the environmental sensitivity at all sections across the river valley, the exact location of the structure was determined by finding a location where the main channel could be traversed with a 60 meter span. This allows the hydraulic integrity of the main channel to be maintained and achieve a span length that is not cost prohibitive. Given the skew of the ROW to the river valley, it was not possible to traverse the back channel with the 60 meter spans. The proposed layout would see the back channel shifted slightly from its present location to be aligned with the 60 meter span opening. This realignment is shown on Drawing G301.

7.0 PREDICTED IMPACTS AND MITIGATION

7.1 Predicted Impacts

Environmental impacts will result from the process of constructing the bridge and during the operation of the bridge. These predicted impacts are described in the following paragraphs.

Impacts During Construction

Given the proximity of the construction activity to the watercourse, the construction activities pose the greatest risk to the environment.

Recreational Fishery

Construction activities will take place on both sides of the main and back channels. Access to the watercourse at these locations will be cut off during construction. Construction of the bridge piers and abutments will require work to be carried out at the river's edge on both sides of the main channel. Disturbance of soils and operation of machinery could lead to soil loss to the river as well as the potential for contaminants (petroleum products) from the machinery.

Construction Debris

Much of the bridge construction will take place above the watercourses, thus providing the potential for construction debris to fall into the water.

Habitat Displacement

The process of construction will require access to the pier and abutment locations by heavy machinery. Access will be required across the back channel from the west to the piers on the island between the back and main channels. This will require a temporary access road and crossing of the back channel. Wetland habitat will be temporarily displaced by the access road. Aquatic habitat may also be affected depending on the crossing method selected.

Impacts During Operation

Habitat Displacement

The piers and abutments will displace tidal marsh and mixed wood habitat, although permanent habitat displacement will be limited to the footprint of these support structures. In addition, approximately 2500 m^2 of marsh habitat will be displaced from the island area between the main and back channels by infilling and realignment of the back channel.

Flood Storage Impacts

The abutments and piers will be constructed in the flood plain of the South River and result in the displacement of flood storage that would otherwise be available during spring peak flows. The volume displaced, however, is negligible relative to the total flood storage capacity at this location.

Impacts to Back Channel and Marsh Habitat

The proposed bridge layout requires a small realignment of the back channel as described in the previous section. The realignment is such that there will be no net loss of aquatic habitat, simply the shifting of the channel approximately 20 m east so that it is aligned with the span opening. There will be the obvious temporary displacement of back channel aquatic habitat during the bridge construction. Approximately 2,500 m^2 of back channel aquatic habitat will be temporarily displaced. The back channel will be replaced in an area that is currently marsh habitat.

In addition, the proposed layout requires some infilling on the west side of the back channel. Fill will be placed in the area between the western abutment and the high ground further to the west, primarily in the area from the back channel was moved. The end result of will be the displacement of 2,500 m^2 of marsh habitat.

Cumulative Encroachment

The new bridge structure is located immediately north of the existing Highway 104 bridge structure. The level of disturbance of the tidal marsh and upland habitat areas will increase as a result of the encroachment of the new bridge structure and road by approximately 100 meters.

7.2 Proposed Mitigation

During Construction

Recreational Fishery

Timing of construction will play an important role in mitigating potential adverse impacts on the recreational fishery in South River at this location. Table 4 summarizes the timing of the various fish species as they utilize the South River for migration.

There are two windows of opportunity identified during which migration and the primary angling effort can be avoided. These are winter months of January, February and March and the summer months (mid July to mid September). The salmon fishing season beings September 1st but angling generally begins around mid September at the earliest. Construction carried out during these two time periods would minimize any impacts on the function of the river for fish passage as well as the use of the river for recreational fishing. In addition, these construction windows will avoid breeding birds.

Sediment and erosion control measures should include:

- Silt fencing around all construction areas including the access road, piers and abutments;
- Use of sheet piling around excavations for piers and abutments
- Use of mulch on exposed areas in order to stabilize soils and reduce erosion
- Silt fence across back channel on the downstream side of the construction work

Water Management During Construction

It is inevitable that some dewatering will be required in the excavations for the piers and abutments. This water will be sediment-laden and will require treatment onsite before it can be discharged to South River. An onsite siltation pond and/or filtration system will be required for each of the west side, island area and east side of the construction area. Discharge through filter bags will likely be required in order to remove finer soil particulate. The system will need to reduce the total suspended solids concentration to less than 25 mg/L before the water can be discharged to the South River system.

Construction Technique

It will be possible to avoid the use of heavy equipment in the main channel through the use of two cranes, one on the east bank and the other on the island area. It should not be necessary for heavy equipment to be in the main channel at all.

Construction Roads and Access

Construction of temporary roads will be necessary to gain access to the piers and abutments. The existing driveway may be utilized on the east side of the main channel, however, the west side will require access through the field, across the back channel to the island area. The back channel will be temporarily infilled for access to the island area and then realigned. A silt curtain consisting of filter fabric and straw bales should be used in the back channel on the downstream side in order to isolate impacts during construction.

7.3 Summary of Cost Estimates

The budget estimate for the proposed bridge structure as describe above is $5,500,000. This includes materials, construction, and environmental protection measures.

Table 5: Cost Summary

Unit	Quantity	Cost
Bridge Railing (concrete)	960 m	$72,000
Parapet, Curbs, Decks, Haunches		$508,300
Parapet, Curbs, Decks, Haunches, Piers	1,350 m^3	$405,000
Abutments	1,680 m^3	$504,000
Abutment Piles		$216,000
Pier Piles		$388,800
Pier Excavation	3,000 m^3	$75,000
Fill Against Structures	12,000 m^3	$300,000
Steel	705 tonnes	$1,762,000
Temporary Roads, Bridges, Signs		$200,000
Silt Fencing, Ponds, Discharge Socks		$100,000
Sheet Piling	1,050 m^2	$186,500
Subtotal		$4,718,100
Contingency		$756,000
Total		**$5,473,100**

8.0 CONCLUSIONS

The South River appears to define the geological contact between limestone bedrock on the west and siltstone bedrock on the east. The potential for Karst topography is greater in the limestone bedrock. Notwithstanding, Karst topography was not encountered during the borehole program carried out for this assessment.

The hydrologic functions of the South River at this location are primarily for conveyance and flood storage purposes. Construction of the bridge will not impact conveyance and will displace a negligible amount of flood storage capacity.

The study site is a highly productive tidal section of the South River. The mixing of denser saltwater provides nutrients to support aquatic production, which in turn provides food to mummichogs, a small common estuarine fish found in high numbers in the area. The site does not, however, provide critical habitat, such as spawning or breeding areas, for important species. Many species of birds and estuarine fish species feed in the area, and a number of highly valued recreational fish species migrate upstream and downstream in the spring and fall.

The study site also has an interesting diversity of species because of its mix of fresh and salt water. For example, both fresh and salt water tolerant species of invertebrates are found in the river substrate. Plant diversity, however, is predominantly salt intolerant, indicating that the area should not be classified as salt marsh.

In terms of unique habitats, the study site is typical of many small sections of Nova Scotia estuaries. Nearby Pomquet estuary provides more unique habitats and supports a number of rare and endangered species. Uncommon species, such as the Nelson Sharp-Tailed sparrow, do occur in the area of the study site, but none are known to be dependent on the site for reproduction.

Within the South River, areas upstream and downstream of the study site provide more critical habitat, especially spawning habitat for fish and breeding habitat for birds. The true salt marsh area downstream of the study site is definitely more important in terms of waterfowl. Above the head of tide, spawning habitat for salmonids, especially the increasingly threatened Atlantic salmon, occurs in many areas.

Construction of a bridge within the study site is less likely to have significant environmental impacts than a site upstream or downstream.

The only residual impact of the bridge will be the displacement of approximately 2,500 m^2 of marsh area primarily from the island marsh habitat located between the back and main channels.

A Certificate of Approval under the Fisheries Act should not be required because there will be no net loss of aquatic habitat. Application will be required under the Navigable Waters Protection Act, although it is anticipated that approval will not be required under this act either.

APPENDIX A

VEGETATION UNITS

Table A-1: 'Island': fresh-water/brackish marsh with wooded centre.

Common Name	Scientfic Name
Agrimony	Agrimonia striata Michx.
American elm	Ulmus americana L.
Apple	Pyrus malus L.
Blue flag iris	Iris versicolor L.
Bluejoint grass**	Calamagrostis canadensis (Michx.)Nutt.
Blunt-leaved dock	Rumex obtusifolius L.
Bulrush**	Scirpus acutus Muhl.
Bulrush**	Scirpus validus Vahl.
Canada goldenrod	Solidago canadensis L
Cat-tail	Typha latifolia L.
Chokecherry	Prunus virginiana L.
Cow-parsnip	Heracleum lanatum Michx.
Dwarf raspberry	Rubus pubescens Raf.
Fireweed	Epilobium angustifolium L.
Freshwater cord grass**	Spartina pectinata Link
Fringed loosestrife	Lysimachia punctata L.
Ground-nut*	Apios americana Medic.
Hawthorn	Crataegus sp.
Joe-pye-weed	Eupatorium maculatum L.
Lady's thumb	Polygonum persicaria L.
Loosestrife	Lysimachia terrestris (L.)BSP.
Meadow-rue	Thalictrum pubescens Pursh.
Meadowsweet	Spiraea alba Du Roi
New England aster	Aster novae-angliae L.
Ninebark	Physocarpus opulifolius (L.)Maxim
Purple avens	Geum rivale L.
Raspberry	Rubus idaeus L.
Red osier dogwood	Cornus sericea L.
Sedge	Carex scoparia Schkuhr.
Sensitive fern	Onoclea sensibilis L.
Speckled alder	Alnus incana (L.) Moench
Strawberry	Fragaria virginiana Duchesne
Tall white aster	Aster umbellatus P. Mill.
Tansey	Tanacetum vulgare L.
Tansey ragwort	Senecio jacobaea L.
Tear thumb	Polygonum sagittatum L.
Touch-me-not	Impatiens capensis Meerb.
Water parsnip	Sium suave Walt.
Water pepper	Polygonum hydropiper L.
White ash	Fraxinus americana L.
Wild morning-glory	Calystegia sepium (L.)R.Br.
Wild rose **	Rosa virginiana Mill.
Willow	Salix sp.

* New record for Antigonish County (Species not rare or threatened)

** Salt-tolerant

Table A-2: River banks: mixed/hardwood forest with hayfield on west side.

Common Name	Species Name
Apple	Pyrus malus L.
Balsam poplar	Populus balsamifera L.
Bayberry	Myrica pensylvanica Mirbel
Canada goldenrod	Solidago canadensis L
Chokecherry	Prunus virginiana L.
Coltsfoot	Tussilago farfara L.
Common comfrey	Symphytum officinale L.
Large-toothed aspen	Populus grandidentata Michx.
New England aster	Aster novae-angliae L.
Orchard grass	Dactylis glomerata L.
Paper birch	Betula papyrifera Marshall
Quackgrass	Elynus repens Gould
Red oak	Quercus rubra L.
Red osier dogwood	Cornus sericea L.
Speckled alder	Alnus incana (L.) Moench
Sugar maple	Acer saccharum Marsh.
Tansey ragwort	Senecio jacobaea L.
Toadflax	Linaria vulgaris Mill.
Timothy	Phleum pratense L.
White ash	Fraxinus americana L.
White spruce	Picea glauca (Moench)Voss
White sweet clover	Melilotus alba Dest.
Wild carrot	Daucus carota L.
Wild rose**	Rosa virginiana Mill.
Willow	Salix sp.
Yarrow	Achillea millefolium L.

** Salt-tolerant

APPENDIX B

SOUTH RIVER BOTTOM

AND

MACROINVERTEBRATES

Table B-1. Sample descriptions of aquatic sediment from South River, Nova Scotia.

Site	Station	Date	Description
West Mid	1	16/10/00	Gravel to rocks, fine sediment, organic matter, reeds, grass, sticks, shell debris and detritus.
Mid Bay 3 ft	2	16/10/00	Fines, medium sand to rocks, organic matter, grass, reeds, leaf parts, shell debris, detritus and clay balls.
Mid Chain 5 ft	3	16/10/00	Fine sand to pebbles, organic matter, seaweed and detritus.
West Outer 5 ft	4	16/10/00	Medium sand to rocks, organic matter, wood bits and detritus.
East Outer 3 ft	5	16/10/00	Medium sand to rocks, mud tubes, organic matter, weeds, moss and detritus.
By Bridge	6	16/10/00	Medium sand to rocks, organic matter, grass, shell debris and detritus.
East Outer	7	16/10/00	Medium sand to rocks, mud tubes, organic matter, algal mats, strands of grass and detritus.

Table B-2. Abundance of biological organisms in aquatic sediment samples from South River, NS

Area Description	**West Mid Chain**	**Mid Bay 3 ft**	**Mid Chain 5 ft**	**West Chain Outer 5 ft**	**East Outer Chain 3 ft**	**East Chain-Bridge**	**East Outer Chain**
Station Number	1	2	3	4	5	6	7
Species							
MARINE							
Gastropoda							
Hydrobia totteni			9	1	2		
Polychaeta							
Nereis diversicolor			22	120			
Marine Oligochaeta			4	6	13	1	7
Platyhelminthes			1	14			
Amphipoda							
Gammarus tigrinus			28	50	17	23	72
Corophium lacustre?			35	64	779		32
FRESHWATER							
Odonata-Anisoptera						1	
Diptera-Ceratopogonidae							2
Diptera-Chironomidae			96	4	431	73	1064
Coleoptera-Elmidae					1		2
Trichoptera					5		
Total (number/sample)	0	0	195	259	1248	98	1179
Number of Taxa	0	0	7	7	7	4	6
Biomass (grams/sample)	0	0	0.492	0.952	2.481	0.423	1.605

APPENDIX C

SOUTH RIVER BIRDS

Table C-1 Birds recorded using the study area.

Scientific Name	Common Name
Podilymbus podiceps	Pied-billed Grebe
Ardea herodias*	Great Blue Heron
Aix sponsa	Wood Duck
Anas rubripes*	American Black Duck
Anas platyrhynchos	Mallard
Anas crecca*	Green-winged Teal
Mergus merganser*	Common Merganser
Pandion haliaetus	Osprey
Haliaeetus leucocephalus	Bald Eagle
Buteo jamaicensis	Red-tailed Hawk
Larus ridibundus	Black-headed Gull
Larus delawarensis	Ring-billed Gull
Larus argentatus*	Herring Gull
Columba livia*	Rock Dove
Zenaida macroura	Mourning Dove
Ceryle alcyon	Belted Kingfisher
Cyanocitta cristata	Blue Jay
Corvus brachyrhynchos*	American Crow
Corvus corax	Common Raven
Poecile atricapilla*	Black-capped Chickadee
Regulus satrapa*	Golden-crowned Kinglet
Turdus migratorius	American Robin
Sturnus vulgaris*	European Starling
Bombycilla cedrorum	Cedar Waxwing
Dendroica coronata	Yellow-rumped Warbler
Geothlypis trichas	Common Yellowthroat
Ammodramus nelsoni	Nelson's Sharp-tailed Sparrow
Melospiza melodia	Song Sparrow
Melospiza georgiana	Swamp Sparrow
Pheucticus ludovicianus	Rose-breasted Grosbeak
Agelaius phoeniceus*	Red-winged Blackbird
Euphagus carolinus	Rusty Blackbird
Quiscalus quiscula	Common Grackle
Carduelis tristis	American Goldfinch

* indicates species observed during the survey of 14 October, 2000

Table C-2. Birds listed in Erskine (1992) that were found in the 10 km square in which the study site is located. C confirmed breeders; Pr probable breeders; Po possible breeders.

Scientific Name	Common Name	Status
Gavia immer	Common Loon	C
Podilymbus podiceps	Pied-billed Grebe	C
Botaurus lentiginosus	American Bittern	C
Anas americana	American Wigeon	C
Anas rubripes	American Black Duck	C
Anas platyrhynchos	Mallard	C
Anas discors	Blue-winged Teal	C
Anas crecca	Green-winged Teal	C
Lophodytes cucullatus	Hooded Merganser	C
Mergus merganser	Common Merganser	C
Mergus serrator	Red-breasted Merganser	C
Pandion haliaetus	Osprey	C
Haliaeetus leucocephalus	Bald Eagle	C
Circus cyaneus	Northern Harrier	Pr
Accipiter striatus	Sharp-shinned Hawk	Pr
Accipiter gentilis	Northern Goshawk	Pr
Buteo platypterus	Broad-winged Hawk	Po
Buteo jamaicensis	Red-tailed Hawk	C
Falco sparverius	American Kestrel	C
Falco columbarius	Merlin	Po
Bonasa umbellus	Ruffed Grouse	C
Falcipennis canadensis	Spruce Grouse	Po
Rallus limicola	Virginia Rail	Po
Porzana carolina	Sora	Pr
Charadrius melodus	Piping Plover	C
Charadrius vociferus	Killdeer	C
Catoptrophorus semipalmatus	Willet	C
Actitis macularia	Spotted Sandpiper	C
Gallinago gallinago	Common Snipe	Pr
Scolopax minor	American Woodcock	Pr
Larus argentatus	Herring Gull	C
Larus marinus	Great Black-backed Gull	C
Sterna hirundo	Common Tern	C
Sterna paradisaea	Arctic Tern	C
Columba livia	Rock Dove (I)	C
Coccyzus erythropthalmus	Black-billed Cuckoo	Po

Table C-2 continued

Scientific Name	Common Name	Status
Bubo virginianus	Great Horned Owl	Po
Strix varia	Barred Owl	Po
Chordeiles minor	Common Nighthawk	Po
Chaetura pelagica	Chimney Swift	Po
Archilochus colubris	Ruby-throated Hummingbird	C
Ceryle alcyon	Belted Kingfisher	C
Sphyrapicus varius	Yellow-bellied Sapsucker	Pr
Picoides pubescens	Downy Woodpecker	Po
Picoides villosus	Hairy Woodpecker	C
Colaptes auratus	Northern Flicker	Pr
Empidonax alnorum	Alder Flycatcher	Po
Empidonax minimus	Least Flycatcher	Po
Tyrannus tyrannus	Eastern Kingbird	Po
Vireo gilvus	Warbling Vireo	Po
Vireo olivaceus	Red-eyed Vireo	C
Perisoreus canadensis	Gray Jay	Po
Cyanocitta cristata	Blue Jay	C
Corvus brachyrhynchos	American Crow	C
Corvus corax	Common Raven	C
Tachycineta bicolor	Tree Swallow	C
Hirundo rustica	Barn Swallow	C
Poecile atricapilla	Black-capped Chickadee	C
Poecile hudsonica	Boreal Chickadee	C
Sitta canadensis	Red-breasted Nuthatch	C
Cistothorus palustris	Marsh Wren	Po
Regulus calendula	Ruby-crowned Kinglet	Po
Catharus ustulatus	Swainson's Thrush	Pr
Turdus migratorius	American Robin	C
Dumetella carolinensis	Gray Catbird	Pr
Sturnus vulgaris	European Starling (I)	C
Bombycilla cedrorum	Cedar Waxwing	C
Vermivora peregrina	Tennessee Warbler	Po
Parula americana	Northern Parula	Po
Dendroica petechia	Yellow Warbler	C
Dendroica pensylvanica	Chestnut-sided Warbler	Po
Dendroica magnolia	Magnolia Warbler	Po
Dendroica tigrina	Cape May Warbler	Po

Table C-2 continued

Scientific Name	Common Name	Status
Dendroica coronata	Yellow-rumped Warbler	Po
Dendroica virens	Black-throated Green Warbler	Po
Dendroica fusca	Blackburnian Warbler	Po
Dendroica palmarum	Palm Warbler	Po
Dendroica castanea	Bay-breasted Warbler	Po
Mniotilta varia	Black-and-white Warbler	Po
Setophaga ruticilla	American Redstart	C
Seiurus aurocapillus	Ovenbird	Pr
Oporornis philadelphia	Mourning Warbler	Po
Geothlypis trichas	Common Yellowthroat	C
Wilsonia pusilla	Wilson's Warbler	Po
Wilsonia canadensis	Canada Warbler	Po
Ammodramus nelsoni	Nelson's Sharp-tailed Sparrow	C
Melospiza melodia	Song Sparrow	C
Melospiza georgiana	Swamp Sparrow	C
Junco hyemalis	Dark-eyed Junco	Po
Pheucticus ludovicianus	Rose-breasted Grosbeak	Pr
Dolichonyx oryzivorus	Bobolink	Po
Agelaius phoeniceus	Red-winged Blackbird	C
Euphagus carolinus	Rusty Blackbird	
Quiscalus quiscula	Common Grackle	C
Icterus galbula	Baltimore Oriole	Pr
Carpodacus purpureus	Purple Finch	C
Loxia curvirostra	Red Crossbill	Po
Carduelis pinus	Pine Siskin	C
Carduelis tristis	American Goldfinch	C
Coccothraustes vespertinus	Evening Grosbeak	Pr
Passer domesticus	House Sparrow (I)	Pr

APPENDIX D

BOREHOLE LOGS

Neill and Gunter
DARTMOUTH, N.S., CANADA

BOREHOLE LOG

Page: 1 of 3

Project: 16053
Borehole: BH-1
Date: Oct. 19/00
FIGURE: 1

Borehole diameter: 0.11
Borehole depth: 15.24m
Top of well screen: –
Bottom of well screen: –
Installation type: BOREHOLE
Drill Type: CME 75

Well screen length: –
Casing length above ground surface: –
Top elevation of casing: –
Casing diameter: –
Top elevation of protective casing: –
Logged by: Dana Wright

Analysis:
- G: Grab Sample
- C: Chemical
- SS: Split Spoon
- ND: Non Detected

Stratigraphic profile

Depth (m)	Symbol	Description	Borehole
0–1		Rootmat –gravel with soft organic brown mud –fluvial deposit	Fill/Till
1–3		Till: –wet brown silty sands and clay –grey/brown in colour –peat layer –fluvial deposit	
3–6		Till: –coarse grained sand with cobbles –fluvial deposit (channel lag)	
6–8		Till: –dense silty sand (Ablation till)	
9–15	15.24	Bedrock: –red siltstone –very severely fractured bedrock –Dip is approximately 20–30 degree Southeast	bentonite
16		EOH	

Samples

N / RQD	Sample number Analysis	Sample Type	% Recovery	Odour
8	1	SS	40	
5	2	SS	50	
1	3	SS	50	
1	4	SS	40	
Refusal	5	SS	2	
26	6	SS	30	
33	7	SS	60	
41	8	SS	35	
54	9	SS	40	
64	10	SS	20	
67	11	SS	50	
65	12	SS	60	
76	13	SS	40	
Refusal	14	SS	20	
25	RC1	RC	19	
87	RC2	RC	22	
68	RC3	RC	10	
35	RC4	RC	10	
73	RC5	RC	10	

Neill and Gunter
DARTMOUTH, N.S., CANADA

BOREHOLE LOG

Page: 2 of 3

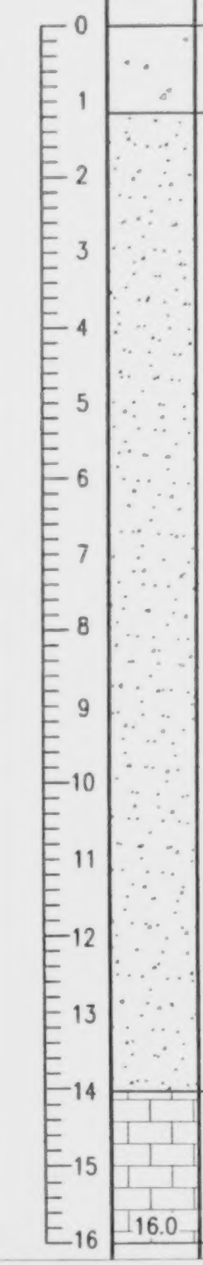
Project: 16053 Borehole: BH-2 Date: Oct. 19/00 FIGURE: 2

Borehole diameter: 0.11
Borehole depth: 17.0m
Top of well screen: –
Bottom of well screen: –
Installation type: BOREHOLE
Drill Type: CME 75

Well screen length: –
Casing length above ground surface: –
Top elevation of casing: –
Casing diameter: –
Top elevation of protective casing: –
Logged by: Dana Wright

Analysis:
G: Grab Sample
C: Chemical
SS: Split Spoon
ND: Non Detected

Stratigraphic profile — Depth (m) / Symbol / Description



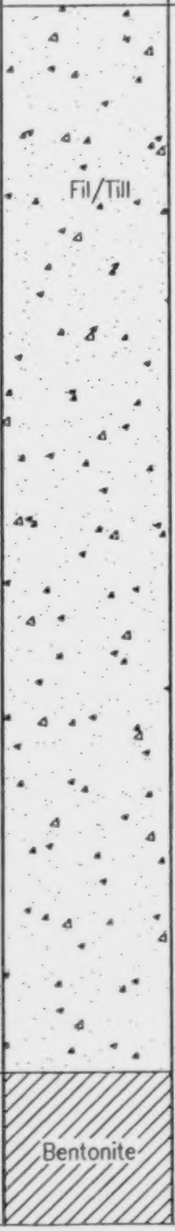
Rootmat: –grass at surface
–silty sand
–fluvial deposit

Till: –brown and gray in colour
–silty sand with clay
–sandstone clasts
(pebble to cobble in size)
(Ablation till)

Bedrock: –very severely fractured limestone

Continued on Page 2

Bedrock



N RQD	Sample number Analysis	Sample Type	% Recovery	Odour
5	1	SS	40	
13	2	SS	60	
34	3	SS	30	
12	4	SS	50	
10	5	SS	30	
15	6	SS	40	
19	7	SS	30	
20	8	SS	40	
22	9	SS	50	
16	10	SS	40	
19	11	SS	40	
25	12	SS	60	
22	13	SS	50	
24	14	SS	70	
40	15	SS	80	
44	16	SS	60	
48	17	SS	60	
29	18	SS	70	
67	19	SS	60	
39	20	SS	40	
Refusal	21	SS	40	
66	RC1	RC	0	
100	RC2	RC	0	m
68	RC3	RC	10	

NG Neill and Gunter
DARTMOUTH, N.S., CANADA

BOREHOLE LOG

Page: 3 of 3

Project: 16053
Borehole: BH-2
Date: Oct. 19/00
FIGURE: 3

orehole diameter: 0.11
Borehole depth: 17.0m
Top of well screen: –
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Top elevation of casing: –
Casing diameter: –
Top elevation of protective casing: –
Logged by: Dana Wright

Analysis:
G: Grab Sample
C: Chemical
SS: Split Spoon
ND: Non Detected

Stratigraphic profile			Borehole						
Depth (m)	Symbol	Description			N RQD	Sample number Analysis	Sample Type	% Recovery	Odour
0		Bedrock: –fractured limestone	Bentonite		40	RC4	RC	13	
17	17.0	E.O.H.							
18									
19									
20									
21									
22									
23									
24									
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27									
28									
29									
30									
31									
32									
33									

APPENDIX E

SALINITY AND CONDUCTIVITY DATA

Table E-1: Salinity and Conductivity

Location	Depth (m)	Conductivity (mmhos)	Salinity (ppt)	Temp (C)
East Channel	0.1	4.3	3.1	16.1
East Channel	0.5	12	9	16
East Channel	1	17.5	11.8	17.6
Middle Channel	1.5	23.7	16	18.7
Middle bay	1	23	16	20
Outer Back Channel	0.1	12.6	8.4	18.6
Outer Back Channel	0.7	25.1	17.1	18.6
West Channel Outer	1.4	27	18	18
Back Channel inner - adjacent to highway	0.4	11.2	16.6	18
Main Channel at Bridge	0.1	0.4	0.1	19
Main Channel at Bridge	1.3	21	15	19

APPENDIX F

ARCHAEOLOGICAL RESOURCE ASSESSMENT

Archaeological Resource Impact Asssessment

Highway 104, South River Crossing

Heritage Research Permit A2000NS37

October 2000

Submitted by:
Davis Archaeological
Consultants Ltd.
6519 Oak Street
Halifax, Nova Scotia
B3L 1H6

Submitted to:
Neill and Gunter,
Design & Consulting Engineers
P.O. Box 2190 East
Dartmouth, Nova Scotia
B2W 3Y2

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Introduction

In September 2000, Davis Archaeological Consultants Limited was awarded the contract by Neill and Gunter Limited to conduct an Archaeological Resource Impact Assessment (Heritage Research Permit A2000NS37; Appendix A) for the South River, Antigonish crossing of Highway 104. The purpose of this assessment was to locate and identify any archaeological resources within the development area and to provide mitigative strategies for those resources.

The field investigations for the Archaeological Resource Impact Assessment were carried out on October 20 and 21, 2000 by a crew of two professional archaeologists who investigated the development area prior to any construction activities.

The following report discusses the details of the natural and cultural environments of the project area, the location and extent of the area, and the methodologies employed in the investigation, as well as the conclusions arrived at through this assessment.

Development Area

The development area is located on the South River in Antigonish approximately 20 meters immediately north of the existing Highway 104 (Figure 1). The project area encompasses a 583 meter by 200 meter corridor which includes a portion of the South River and associated salt marsh. The area is bounded on the west by a region of disturbed high ground and on the east by a region of minimally disturbed low ground which quickly slopes upward as it crosses South Side Harbour Road (Figure 2).

The development area lies within the terrestrial region known as the Northumberland Plain/St. George's Bay. Rivers within this region drain north toward St. George's Bay. Coastal areas of this region traditionally served as summer camps for Mi'kmaq. Later, English and Scottish settlers cleared much of this land for farming. Several grist mills were in operation in the Northumberland Plain region in the past.[1]

Historical Background

Archival Sources

An archival study of the vicinity of the development area was conducted prior to investigations in the field. A list of archival resources that were consulted is provided in Appendix E.

According to these archival sources, the first Europeans in Antigonish County were the Acadians.[2] After their expulsion, several groups of European and American settlers moved in. In

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[1] Nova Scotia Museum (1996)

[2] History of the County of Antigonish (PANS Nova Scotia Scrapbook, MG 9 Vol. 37). Pp. 231.

1784, the land surrounding Antigonish harbour on both sides was granted by Governor Parr to Lieutenant Colonel Timothy Hierlihy and 88 members of his regiment. This grant included 21,600 acres of land and was known as the "Soldier's Grant". The area surrounding Antigonish was heavily forested when Hierlihy and his regiment arrived. As a result, they were isolated from the rest of the province and the only way in or out of the area was by way of the harbour. The soldiers were granted one quarter acre of land each on which to build their log homes in addition to an allotment of land from which to farm. However, hardship, mainly poor weather and lack of supplies, met these soldiers and many sold their farms within the first few years and moved on.[3]

After Hierlihy's regiment took up farms, Montague's regiment which consisted of Loyalists and refugees from a battle in South Carolina settled in Antigonish County on the south side of the harbour in the late eighteenth century.[4]

In 1796, the "Yankee Grant" was formed which included 23,000 acres of land on the western boundary of the Soldier's Grant. The grant was taken up by one Jotham Blanchard from New Hampshire and was intended to entice settlers from the New England states.[5]

The town of Antigonish was established in 1804. The roads through the town at that time were only footpaths but were eventually cleared on either side. Still, everything entered and left by way of the harbour. By 1827, there were 45 houses in addition to other buildings (schools, churches, shops, mills) in the town. Timber was exported while the land was being cleared.[6]

In the first half of the nineteenth century, the Upper South River had become thickly settled by Scottish emigrants who had cleared and farmed the land.[7]

Local Sources

In addition to archival resources, Jocelyn Gillis, manager at the Antigonish Heritage Museum, and Fraser Dunn, South River resident and local historian, were consulted regarding the cultural history of the South River vicinity. Ms. Gillis indicated that the old Dunn residence, constructed in the early nineteenth century, is one of the oldest standing buildings in the vicinity of the town of Antigonish. Although this house is located outside the study area, it does lie in the project corridor and, as such, concern was expressed regarding its impact by development in this area.

Mr. Dunn provided a photograph of the South River area likely dated between the 1880s and 1890s (Figure 3). This photograph shows the location of the original 1853 bridge that spanned the South River as well as several buildings in its vicinity. Among these buildings are a schoolhouse built in 1873 and a carriage house, grist mill, shop, and cheese factory all owned by one Hugh MacDonald who was reportedly the richest resident of Nova Scotia at that time. Most of these buildings are located outside the study area to the south with the exception of the carriage house which was located at the intersection of the present highway 104 and the driveway to Kevin Partridge's home.

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[3] Ibid. Pp. 232.

[4] MacDonald, J.W. (1876). Pp. 9-10.

[5] Ibid. Pp. 20.

[6] Ibid. Pp. 32-33.

[7] History of the County of Antigonish. (PANS Nova Scotia Scrapbook, MG 9 Vol. 37). Pp. 247.

Mr. Dunn was also able to point out several historical resources located outside the study area including an early nineteenth century cemetery located approximately 250 meters north of the study area's north boundary on the west side of the river (Plate 1).

Mr. & Mrs. Kevin Partridge, local residents and business operators, were also consulted concerning the history of the vicinity of their property located on the corner of Highway 104 and South Side Harbour Road on the east bank of South River. They indicated that the landscape on their property is much the same as it was when they built their home in 1989, except for some modification to the hill behind their house bounding the South Side Harbour Road. They also indicated that since the 1940s, a cottage sat on the spot where their present house is built.

Methodology

The development area was surveyed on foot by a crew of two persons. The entire 583 meter by 200 meter study area was investigated with special attention paid to the area of high ground west of the river, as areas of high ground are more suitable for cultural activity than areas of low ground which may experience regular or occasional flooding.

On the west side of the river, plowing resulted in disturbance with numerous small areas of exposed soil present. These exposed areas were observed for presence of archaeological materials which proved negative. The small area of low ground to the south east (at the intersection of the north - south and east - west tree lines) as well as a portion of the west river bank adjacent to it was heavily disturbed due to plowing (Plate 2).

Stone field clearings were found in several areas along the north - south tree line on the west side of the river and are a result of recent plowing on the adjacent high ground. There were also scattered middens in this tree line containing modern refuse (aluminum, galvanized metal, plastic, car parts, and so on). These middens extend downslope toward the river. The west bank of the river has suffered extensive erosion and has resulted in further disturbance to this area.

On the east side of the river, the landscape remains much the same as it was in the nineteenth century. Exposed areas are present as a result of minimal disturbance. However, upon investigation, these areas proved negative for archaeological resources. Modern refuse is scattered along the base of the hill bounding the road and is likely associated with the 1940s cottage and the current occupants.

Reconnaissance on the east bank of the river at the south boundary of the development area yielded one feature of interest, the remains of a circular or square stack of cut stones. Upon inspection of the photograph provided by Fraser Dunn, it became apparent that this feature was related to the 1853 bridge and is likely part of the easternmost bridge footing.

No evidence of the nineteenth century buildings shown in the photograph remain. It is known that the 1873 school was relocated north of its original position. The other buildings were likely destroyed by construction of the paved highway in 1935 and by construction of the Trans-Canada Highway in 1955.

Subsurface testing was conducted on the west side of the river at the summit of the high ground as well as along the west bank of the river. Seven 50 centimeter by 50 centimeter tests spaced five meters apart on the high ground (Figure 4) (Plates 3 and 4) proved negative for archaeological resources and confirmed that this area was heavily disturbed. Ten tests were conducted on the west bank at five-meter intervals (Figure 5) (Plate 5) as well as two others 7 meters away on the low ground at the corner of the north - south and east - west tree lines also spaced five meters apart (Figure 5) (Plate 6). All twelve tests were negative for archaeological resources.

Resource Evaluation

Much of the land on the western side of the river within the development area has been disturbed by recent plowing as well as by erosion resulting from the river's action. Although the eastern area was once the site of much cultural activity, little evidence of that activity remains. Previous construction has resulted in the destruction of many of the nineteenth century buildings that were located here. The only observed remnant of past features is an 1853 bridge footing which has, for the most part, been destroyed by previous construction and/or the tidal action of the river.

This feature was significant in allowing us to locate associated features as well as others features in its vicinity. However, due to the recent age of the feature in question as well as the impact it has been subjected to by past construction activities, it is of low archaeological significance.

The area in which the nineteenth century carriage house was located is of concern, however, since it is located within the study area. There have been high levels of modification to this area by way of construction of nearby houses and associated landscaping as well as by construction of the Trans-Canada highway. It is possible that evidence of this structure remains beneath the existing highway and will be impacted by construction.

Although the cemetery to the north of the study area as well as the early nineteenth century house to the west are located outside the study area, they are of high archaeological significance. Therefore, given public expressions of concern regarding their potential impact during construction of the South River bridge and associated highway, these areas should be the subject of further studies should the development proceed.

Conclusions and Recommendations

Archival and local sources have yielded a wealth of information concerning archaeological resources in the study area. However, field investigations yielded no evidence of significant resources within the study area. Yet concern remains for the fate of the Dunn family residence as well as the nearby cemetery. In addition, given the past cultural activity in this vicinity, concern is expressed for potential heritage resources such as the carriage house that may be near or under current buildings or structures including the existing highway. As a result, it is recommended that this area be monitored by a trained archaeologist during construction of the South River bridge and associated highway.

Figure 1: Development Area Location

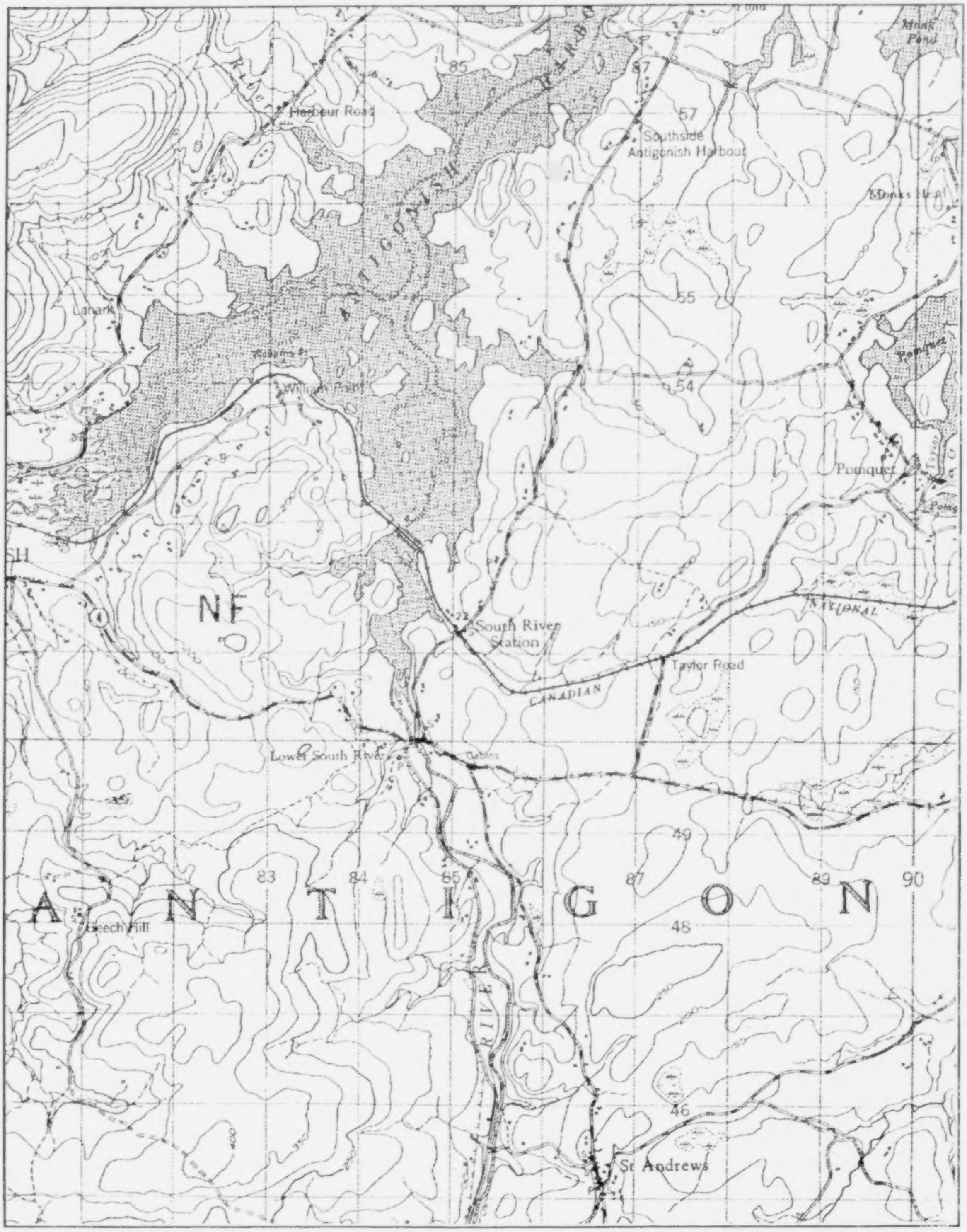


Figure 1: Development Area Location

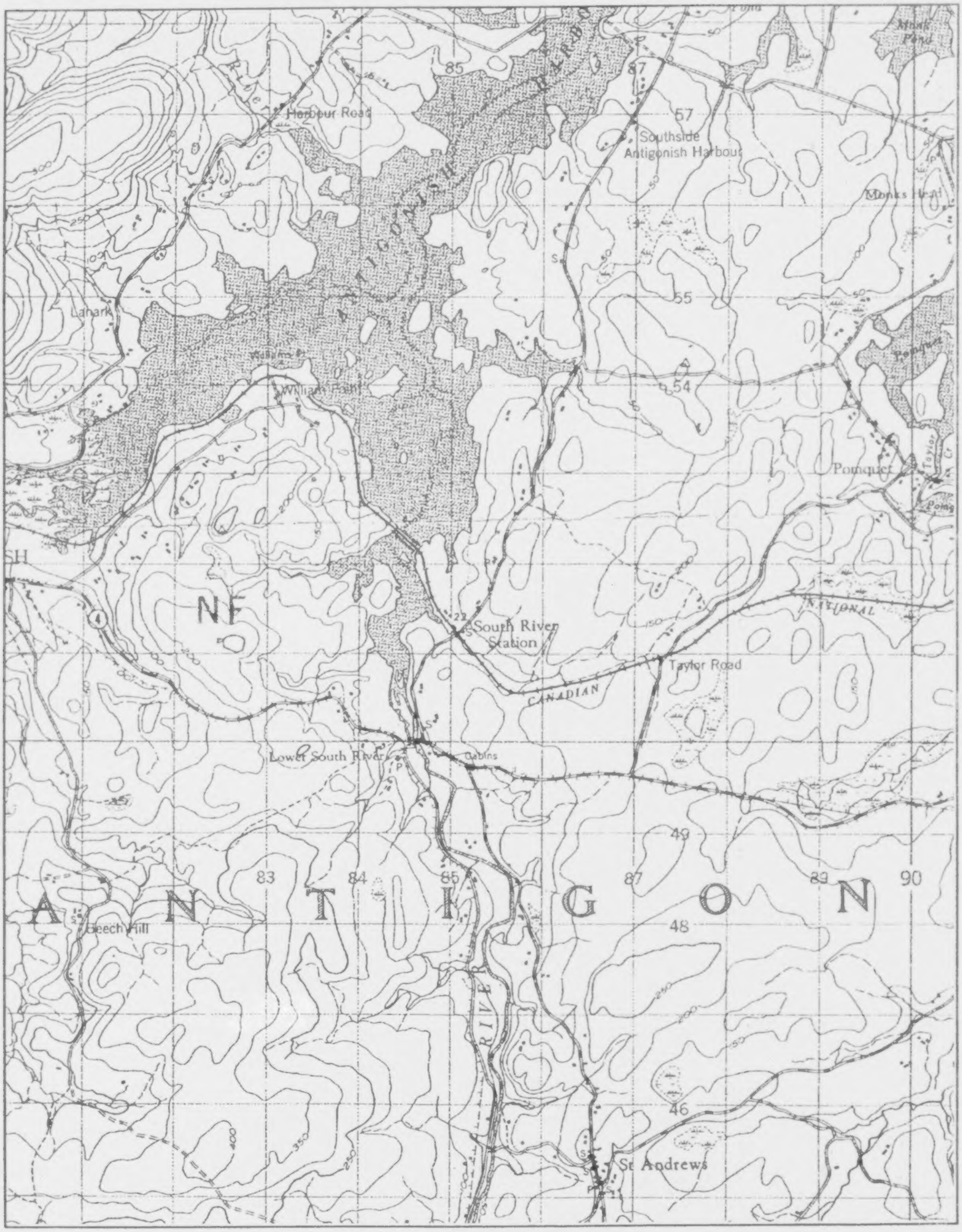


Figure 2: Highway 104 South River Crossing (Development Area Map)
(Courtesy Neill and Gunter Design and Consulting Engineers Limited)

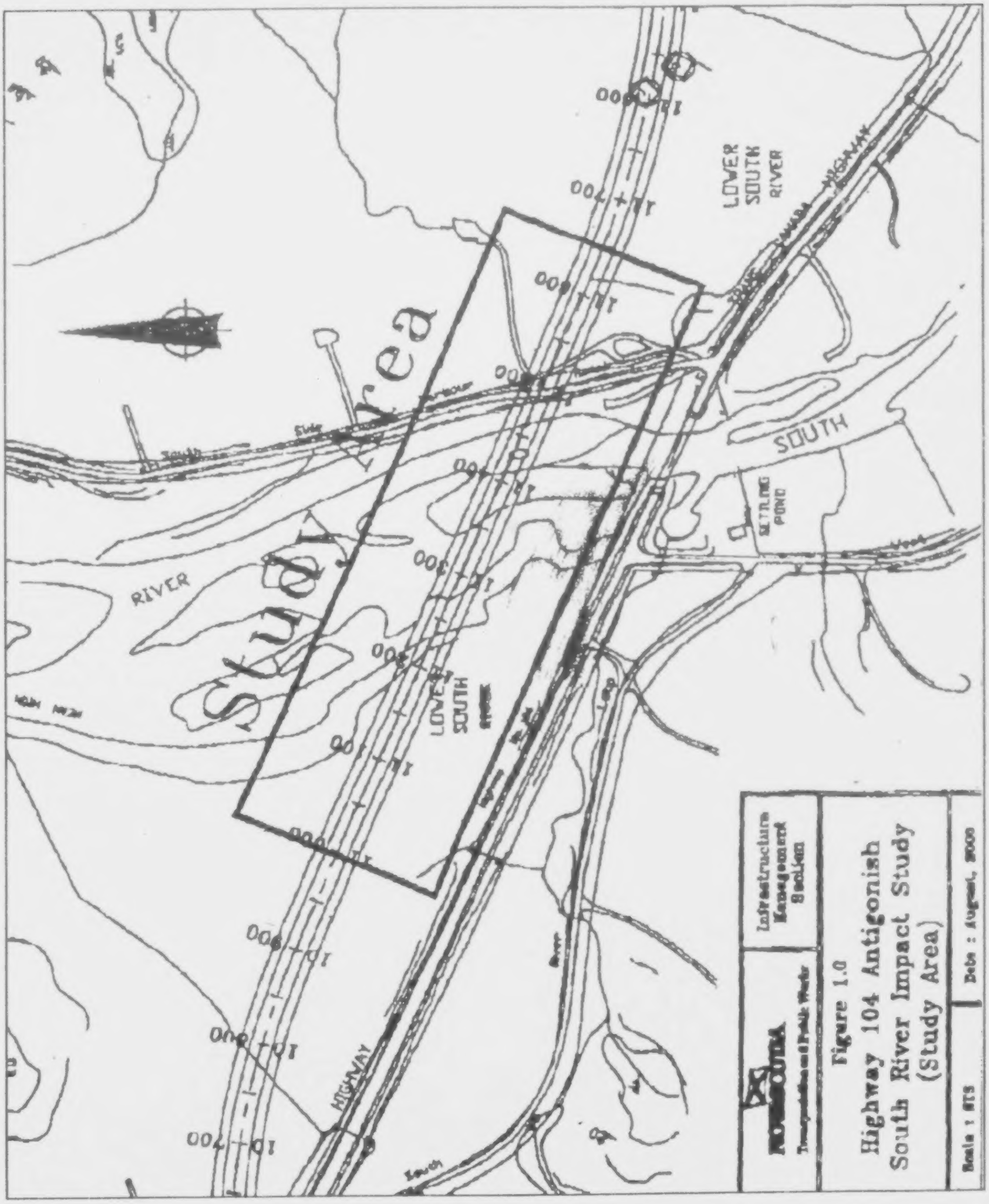
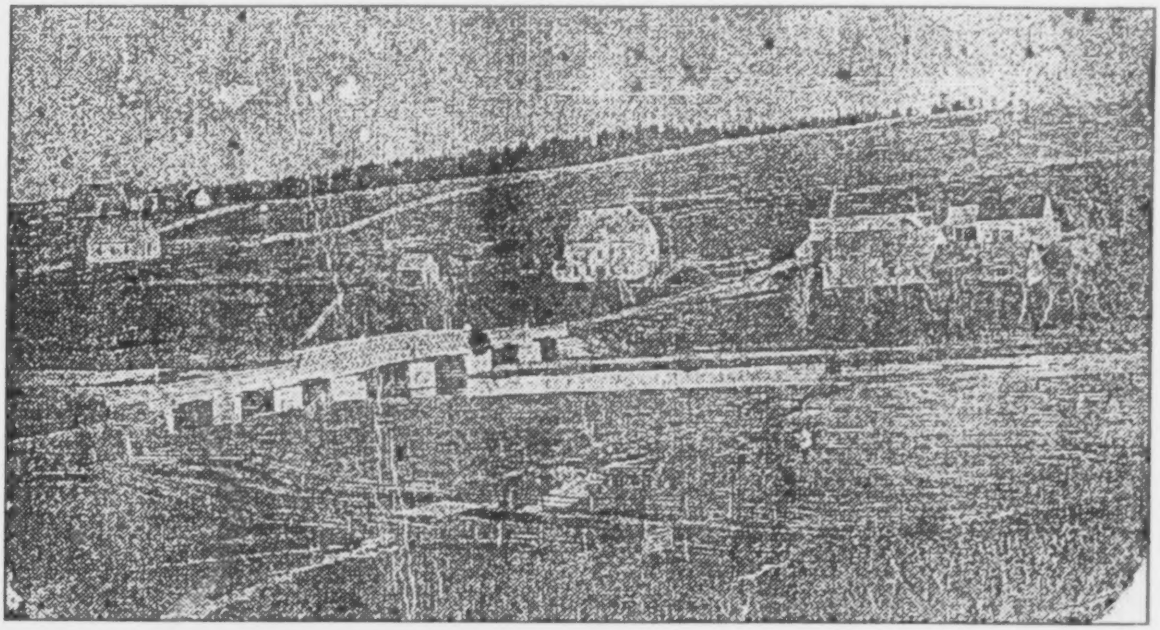


Figure 3: Late 19th Century Photograph Showing Location of 1853 Bridge
(Courtesy Mr. Fraser Dunn)



Upper left - the Rory "Mor" Chisolm - Larry MacDonald - Billie Chisolm property

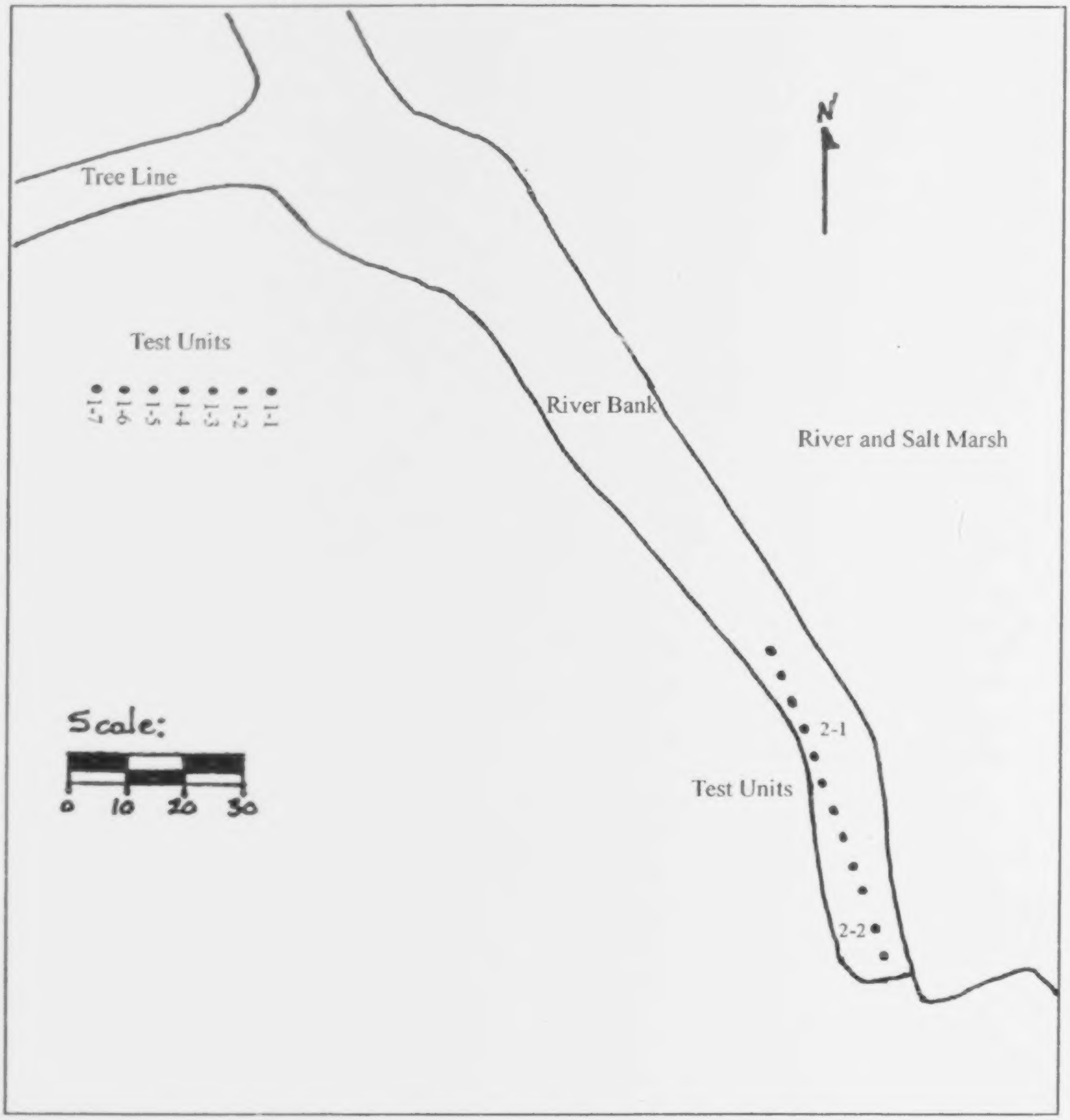
Lower left - the Lower South River School Section No. 20 Constructed in 1872

Center - the home of Charles Fraser

Front right - the old cheese factory]

Back right - store and carriage house and house now owned by Rita "Val" Chisolm

Figure 4 - Location of Test Units



APPENDIX A:

Heritage Research Permit A2000NS37

NOVA SCOTIA
Tourism and Culture

Nova Scotia Museum
Special Places Protection Act,
R.S.N.S. 1989

Application for
Heritage Research Permit
(Archaeology)

(Original becomes Permit when approved by the Executive Director of the Nova Scotia Museum)

Permit No. A2000NS37

The undersigned Stephen A. Davis

of 6519 Oake Street, Halifax, N.S. B3L 1H6

representing (institution) Davis Archaeological Consultants Ltd.

hereby applies for a permit under Section 8 of the Special Places Protection Act to carry out archaeological investigations during the period:

from asap to 30 December 2000

at South River crossing by Highway 104

general location Antigonish

specific location(s) (cite Borden numbers and UTM designations where appropriate n/a
n/a

and as described separately in accordance with the attached Project Description. Please refer to the appropriate Archaeological Heritage Research Permit Guidelines for the appropriate Project Description format.

I certify that I am familiar with the provisions of the Special Places Protection Act of Nova Scotia, and that I will abide by the terms and conditions listed in the Heritage Research Permit Guidelines for the category (check one).

- ☐ Category A - Archaeological Reconnaissance
- ☐ Category B - Archaeological Research
- ☒ Category C - Archaeological Resource Impact Assessment

Signature of applicant Stephen A. Davis **Date** 29/09/00

Approved:
Executive Director **Date** 02/10/00

APPENDIX B:
Field Notes

October 20, 2000

We started at South Side Harbour Road and checked out the area north of the daycare. This area is mostly swamp. There are numerous apple trees bounding the high ground.

Field clearance on south east corner of study area outside the development boundary.

Rusted wire fence running north - south approximately 10 m east of South Side Harbour Road. Another wire fence running roughly east - west on top of the high ground. There is a gap in the fence downslope. It then continues and intersects the north - south fence. Apple tree on corner of intersecting fences.

Checked out area around Kevin Partridge's home (west side of South Side Harbour Road at Hwy 104 intersection). The area in back is exposed hill. The hill levels out onto flat ground bounding the river (flat ground approximately 30 m wide). Exposed area of soil in front yard, likely an over-grown rhubarb patch. Checked this area for precontact and historical materials – negative.

3 m x 3 ½ m garden (exposed soil) in front yard. Contains one rusted wire nail, likely associated with 1940s cottage Mrs. Partridge indicated once sat on this lot. There are cut stones in the garden as well as in back on the exposed hill.

Refuse on hill near where driveway intersects with highway. Likely associated with 1940s cottage (tires, wood, heavy machinery, etc.).

On south side of highway, there are the remains of an old asphalt road running off highway opposite South Side Harbour Road.

On north side of highway behind Kevin Partridge's garage approximately 15 m east of the river's edge beneath bridge,stacked cut stones are visible in trees. Small stream running along side the feature. It appears rounded. Possibly a footing or pier. A few cut stones are scattered in the vicinity.

Went to see Jocelyn Gillis at Antigonish Heritage Museum. She showed us a photo of the old Dunn family residence (possibly the oldest building in town built in the first part of 19th century). She also put us in contact with Fraser Dunn , local historian (whose family owned the old house) who we set up a meeting with to discuss history of the area and any resources that may remain.

Over the phone, Mr. Dunn indicated that this immediate area was once the site of an 1873 schoolhouse as well as a 19th century grist mill, cheese factory, and store owned by Hugh MacDonald (richest man in N.S. at the time). Also, he indicated that there was a carriage house on Kevin Partridge's property.

Meeting with Fraser Dunn:

Mr. Dunn provided a photocopy of a picture of the 1853 that spanned South River that also shows Hugh MacDonald's grist mill, store, and cheese factory, the carriage house, and the 1873 schoolhouse. The photo dates between the 1880s and 1890s. The schoolhouse in the picture still exists but has since been moved further north outside our study area.

According to the photo, the carriage house was located on the south east corner of the study area. It was likely impacted by several factors (including construction of houses on south side of highway, construction of cottage on K. Partridge's property in 1940s, construction of Trans-Canada highway in 1955, and landscaping of K. Partridge's property in late 1980s) which lead to its eventual destruction.

Store, grist mill, and cheese factory were located opposite the carriage house on south side of highway 104 and were likely destroyed by many of the same factors that impacted the carriage house.

Mr. Dunn has done extensive work on the cemetery north of the study area including identifying and plotting marked and unmarked graves. According to him, the cemetery dates to about 1805. The earliest burial marker is from1811 for "Lydia, wife of Rod Grant". There was no church at that point. The cemetery was later associated with St. Andrew's parish (1837). Rod (Rory) Grant owned part of the east portion of the study area and beyond (to the east), encompassing 200 acres.

Mrs. Dunn indicated a school dated 1812 located outside the study area, to the south.

According to Mr. Dunn, the back channel of the river on the north and south sides of the highway once connected. He suspected that the feature we encountered under the existing bridge may be the foundation of a building (either the residence or a shop) owned by one Charles Fraser. The Fraser shop was there until 1955 when the highway went through.

Mr. Dunn suspects that "Town Point" to the north of the study area is the spot where Hierlihy's regiment buried their dead. It is located near the existing railway. Natives were buried here as well as others passing through on their way into the harbour.

Mr. Dunn has identified 282 burials in the 1805 cemetery with about 40 headstones (some toppled over and broken).

According to the photo Mr. Dunn gave us, the feature we encountered under the bridge is likely the remains of a rip-rap footing (footing constructed of wood and filled with stones) associated with the 1853 bridge over the river.

October 21, 2000

We began on the west side of the river and made our way to the hilltop. There were some exposed areas of soil resulting from recent plowing which we inspected for archaeological materials. No such materials were present. The summit of the hill appears to have been modified (slope may have been dug out next to the tree line).

We made our way north through the tree line so that we were within view of the cemetery. The cemetery is located 200 - 300 meters outside the study area.

Stone field clearing found in north - south tree line approximately 100 m from the small east - west tree line. Numerous other field clearings littler this tree line. The area between the cemetery and tree line has been plowed.

On the north edge of the study area, there is scattered refuse in the north - south tree line approximately 120 m north of east - west tree line (aluminum, galvanized metal, plastic, car parts, etc.) This midden extends downslope approximately 15 m toward the river.

Old road running down to river on north -south tree line. Road runs south. Outside the study area.

By the cemetery, on the bank over the river is a plowed area which is exposed. There is a pulley system in the nearby tree. Building pushed over bank. Indicative of recent camp. Modern refuse in the vicinity.

Most recent burial in cemetery is for Christopher J. Chisolm dated 1932.

Encountered a soil test area on bank of river at intersection of north - south and east - west tree lines.

On summit of hill, ran an east - west line of 7 shovel test 50 cm by 50 cm at 5 m intervals. All units were negative for archaeological resources. Soil was a medium brown organic soil. Bottom was gravel.

Put in 10 test units at 5 m intervals along west bank face of river. This area is eroded and heavily disturbed. No distinctive soil horizons in most of the units. Negative for archaeological resources. Also put in two test units near soil test area (at intersection of tree lines) 7 meters from first line of test units. These, too, were heavily disturbed and proved negative.

Dropped by to speak to Kevin Partridge. He located the native cemetery approximately 3 km north of his home beside the railway on "the point" (same spot indicated by Fraser Dunn).

The road that we discovered on the west side of the river near the cemetery likely continues on the east side of the river as Mr. Partridge pointed out a road opposite the one of the west bank. Perhaps there was a ferry service across the river at one time.

Mr. Partridge also confirmed Mr. Dunn's statement that the river was diverted on the west side when the highway was constructed.

Mr. Partridge said that he cut into the bank behind the house when it was constructed and didn't notice anything out of the ordinary. It was mostly gravel with some sand.

Took Mr. Partridge down to look at stone feature under bridge. He suspected beforehand that it may be stones that he had brought in. Upon inspection, he said that he hadn't seen this feature before. Given its location, it is most certainly the 1853 bridge footing.

Mr. Partridge also said that the landscape on his property hasn't changed much from its original state except for some modification to the driveway as well as to the area where his outbuildings area located. He bulldozed this area but did not see anything other than gravel.

APPENDIX C:
Plates

Plate 1 – Early nineteenth century cemetery north of study area, looking north east

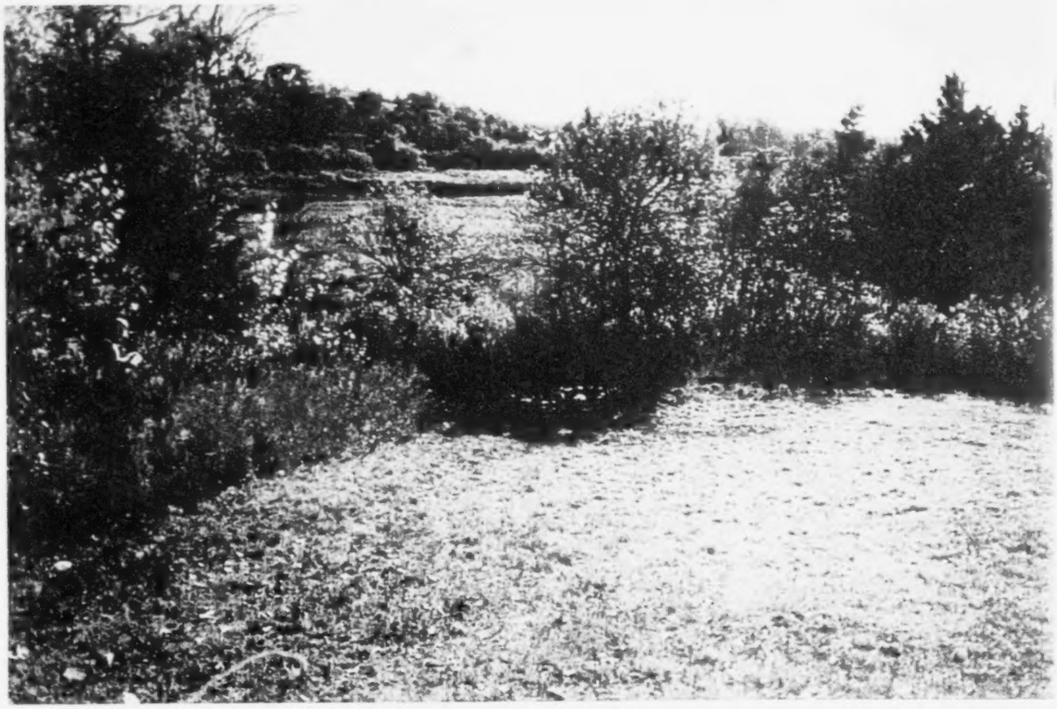


Plate 2 – Bulldozed area at intersection of north – south and east – west tree lines, looking south east

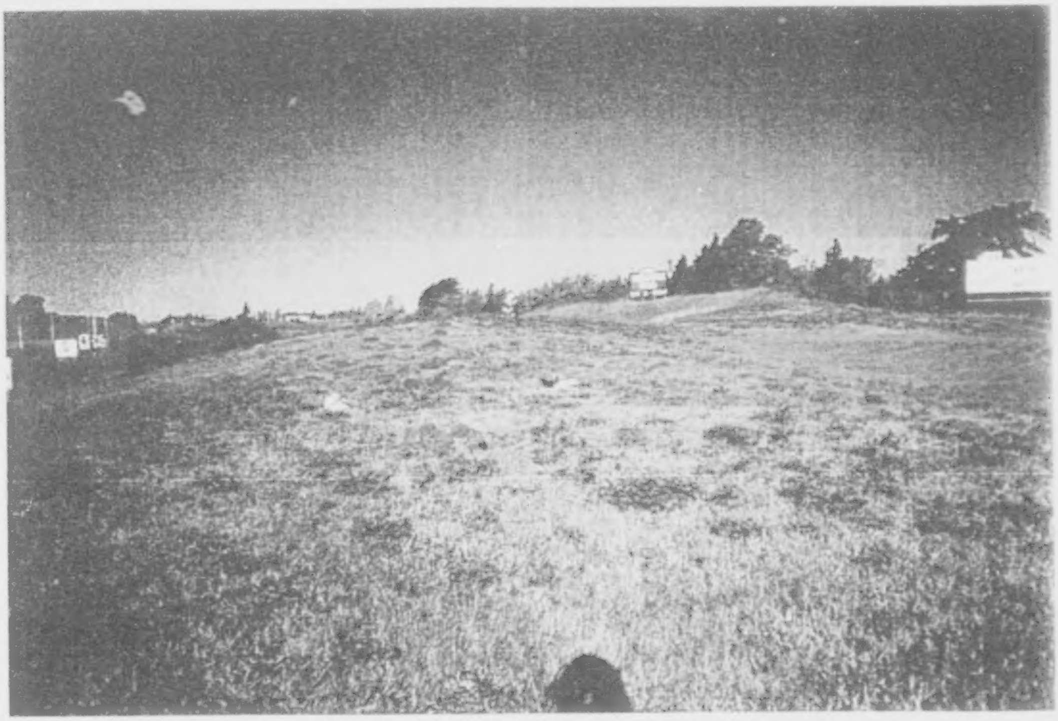


Plate 3 – Test units on summit of high ground, west side of river, looking west

Plate 4 – Test units on summit of high ground, west side of river, looking east

Plate 5 – Line of vertical cut test units on west river terrace, looking south

Plate 6 – Line of test units on low ground of west river terrace, looking south

APPENDIX D:
Test Unit Level Records

Excavation / Test Unit # 1-1

Borden#/Site Name :

Location : South River

Project : Hwy 104 Antigonish Bi-pass

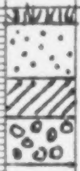
Client : Neill & Gunter Consulting Engineers

Team Leader : S. Davis

Excavated By : S. Davis

Excavation Date : Oct. 21/00

Excavation Type : 50 x 50 cm shovel

SUBSURFACE PROFILE						ARTIFACTS		SAMPLES	
(cm) Depth Scale	Symbol	Depth in cm	Layer/ Lot #	Description (e.g.- Brown Forest Podzol, light brown silty sand)	Inclusions (e.g.- Charcoal, Cultural Stones)	Description	Bag #	Description	Bag #
		2	1	Sod (grass & roots),					
10		10	2	md. brown organic					
		16	3	orange sterile					
20		23	4	1cm gravel					
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									

Remarks No cultural materials present

Photographic Record : Roll # Frame #('s) **Reference to Map :**

Recorder's Initials: AM

Excavation / Test Unit # 1-2

Borden#/Site Name :

Location : South River

Project : Hwy 104 Antigonish Bi-pass

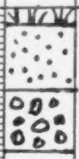
Client : Neill & Gunter Consulting Engineers

Team Leader : S. Davis

Excavated By : S. Davis

Excavation Date : Oct. 21/00

Excavation Type : 50 x 50 cm shovel

SUBSURFACE PROFILE						ARTIFACTS		SAMPLES	
Depth Scale (cm)	Symbol	Depth in cm	Layer/ Lot #	Description (e.g.- Brown Forest Podzol, light brown silty sand)	Inclusions (e.g.- Charcoal, Cultural Stones)	Description	Bag #	Description	Bag #
		2	1	Sod (grass & roots),					
10		12	2	md. brown organic					
20		21	4	Gravel (<1cm size)					
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									

Remarks No cultural materials present. Lot 2 disturbed.

Photographic Record : Roll # Frame #('s)

Reference to Map :

Recorder's Initials: AM

Excavation / Test Unit # 1-3

Borden#/Site Name :

Location : South River

Project : Hwy 104 Antigonish Bi-pass

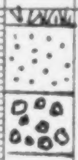
Client : Neill & Gunter Consulting Engineers

Team Leader : S. Davis

Excavated By : S. Davis

Excavation Date : Oct. 21/00

Excavation Type : 50cm x 50cm shovel

SUBSURFACE PROFILE						ARTIFACTS		SAMPLES	
Depth Scale (cm)	Symbol	Depth in cm	Layer/ Lot #	Description (e.g.- Brown Forest Podzol, light brown silty sand)	Inclusions (e.g.- Charcoal, Cultural Stones)	Description	Bag #	Description	Bag #
		2	1	Sod (grass & roots)					
10		12	2	md. brown organic					
20		21	4	<1 cm-sized gravel					
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									

Remarks No cultural materials present. Lot 2 disturbed.

Photographic Record : Roll # Frame #('s)

Reference to Map :

Recorder's Initials: AM

Excavation / Test Unit # 1-4

Borden#/Site Name :

Location : South River

Project : Hwy 104 Antigonish Bi-pass

Client : Neill & Gunter Consulting Engineers

Team Leader : S. Davis

Excavated By : S. Davis

Excavation Date : Oct. 21/00

Excavation Type : 50cm x 50cm shovel

SUBSURFACE PROFILE						ARTIFACTS		SAMPLES	
(cm) Depth Scale	Symbol	Depth in cm	Layer/ Lot #	Description (e.g.- Brown Forest Podzol, light brown silty sand)	Inclusions (e.g.- Charcoal, Cultural Stones)	Description	Bag #	Description	Bag #
	vvv	2	1	Sod (grass & roots),					
10	∴	16	2	md. brown organic					
20	○								
	○	30	4	<1cm-sized gravel					
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									

Remarks No cultural materials present. Lot 2 disturbed.

Photographic Record : Roll # **Frame #('s)** **Reference to Map :** **Recorder's Initials:** AM

Excavation / Test Unit # 1-5

Borden#/Site Name :

Location : South River

Project : Hwy 104 Antigonish Bi-pass

Client : Neill & Gunter Consulting Engineers

Team Leader : S. Davis

Excavated By : S. Davis

Excavation Date : Oct. 21/00

Excavation Type : 50cm x 50cm shovel

SUBSURFACE PROFILE						ARTIFACTS		SAMPLES	
Depth Scale (cm)	Symbol	Depth in cm	Layer/ Lot #	Description (e.g.- Brown Forest Podzol, light brown silty sand)	Inclusions (e.g.- Charcoal, Cultural Stones)	Description	Bag #	Description	Bag #
		3	1	Sod (grass & roots)					
10		10	2	md. brown organic					
20		22	4	<1cm-sized gravel					
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									

Remarks No cultural Materials present. Lot 2 disturbed.

Photographic Record : Roll # Frame #('s)

Reference to Map :

Recorder's Initials: AM

Excavation / Test Unit # 1-6

Borden#/Site Name :

Team Leader : S. Davis

Location : South River

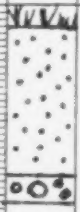
Excavated By : S. Davis

Project : Hwy 104 Antigonish Bi-pass

Excavation Date : Oct. 21/00

Client : Neill & Gunter Consulting Engineers

Excavation Type : 50 x 50 cm shovel

SUBSURFACE PROFILE						ARTIFACTS		SAMPLES	
Depth Scale (cm)	Symbol	Depth in cm	Layer/ Lot #	Description (e.g.- Brown Forest Podzol, light brown silty sand)	Inclusions (e.g.- Charcoal, Cultural Stones)	Description	Bag #	Description	Bag #
		3	1	Sod (grass & roots),					
10									
20		25	2	md. brown organic					
30		29	4	<1cm-sized gravel					
40									
50									
60									
70									
80									
90									
100									
110									
120									

Remarks No cultural material present. Lot 2 disturbed.

Photographic Record : Roll # Frame #('s)

Reference to Map :

Recorder's Initials: AM

Excavation / Test Unit # 1-7

Borden#/Site Name :

Location : South River

Project : Hwy 104 Antigonish Bi-pass

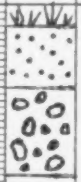
Client : Neill & Gunter Consulting Engineers

Team Leader : S. Davis

Excavated By : S. Davis

Excavation Date : Oct. 21/00

Excavation Type : 50 x 50cm shovel

SUBSURFACE PROFILE						ARTIFACTS		SAMPLES	
Depth Scale (cm)	Symbol	Depth in cm	Layer/ Lot #	Description (e.g.- Brown Forest Podzol, light brown silty sand)	Inclusions (e.g.- Charcoal, Cultural Stones)	Description	Bag #	Description	Bag #
		3	1	sod (grass & roots)					
10		12	2	md. brown organic					
20		25	4	<1cm-sized gravel					
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									

Remarks No cultural materials present. Lot 2 disturbed.

Photographic Record : Roll # Frame #('s)

Reference to Map :

Recorder's Initials: AM

Excavation / Test Unit # 2-1

Borden#/Site Name :

Location : South River

Project : Hwy 104 Antigonish Bi-pass

Client : Neill & Gunter Consulting Engineers

Team Leader : S. Davis

Excavated By : S. Davis

Excavation Date : Oct. 21/00

Excavation Type : 60cm vertical cut

SUBSURFACE PROFILE						ARTIFACTS		SAMPLES	
Depth (cm) Scale	Symbol	Depth in cm	Layer/ Lot #	Description (e.g.- Brown Forest Podzol, light brown silty sand)	Inclusions (e.g.- Charcoal, Cultural Stones)	Description	Bag #	Description	Bag #
	▨	3	1	Dark brown organic					
10 20	⁘	23	2	medium brown organic					
30			3	sterile (orange-brown sandy silt)					
40									
50									
60									
70									
80									
90									
100									
110									
120									

Remarks Lot 1 heavily eroded and disturbed. No cultural Materials present.

Photographic Record : Roll # Frame #('s) Reference to Map :

Recorder's Initials: AM

Excavation / Test Unit # 2-2

Borden#/Site Name :

Location : South River

Project : Hwy 104 Antigonish Bi-pass

Client : Neill & Gunter Consulting Engineers

Team Leader : S. Davis

Excavated By : S. Davis

Excavation Date : Oct. 21/00

Excavation Type : 50cm x 40cm shovel

SUBSURFACE PROFILE						ARTIFACTS		SAMPLES	
Depth Scale (cm)	Symbol	Depth in cm	Layer/ Lot #	Description (e.g.- Brown Forest Podzol, light brown silty sand)	Inclusions (e.g.- Charcoal, Cultural Stones)	Description	Bag #	Description	Bag #
	▨	8	1	Dark brown organic					
10	⁘								
20	⁘								
	⁘	28	2	medium brown organic					
30									
40			3	sterile (orange-brown sandy silt)					
50									
60									
70									
80									
90									
100									
110									
120									

Remarks No cultural materials present. Lot 1 in this unit has not been disturbed.

Photographic Record : Roll # Frame #('s)

Reference to Map :

Recorder's Initials: AM

APPENDIX E:

Archival Sources Consulted

Archival Sources Consulted

Anonymous

Antigonish Harbour and Vicinity. (PANS V7/239 - und.)

Brief History of Antigonish Town. (PANS CS 90 W57 W57).

Crown Land Grants. Sheet No. 99. (PANS V/11 Sheet No. 99).

History of Antigonish County. (PANS MG 4 Vol. 243).

"History of the County of Antigonish". (PANS Nova Scotia Scrapbook MG 9 Vol. 37, Pp. 231-250).

Sketch of Farm Lots on Antigonish Harbour c. 1820. (PANS MG 9 Vol. 103 #28; micro reel #15,162).

1830 Great Map of Nova Scotia. (PANS Drawers 2.1.1 to 2.1.19; S114[4]).

1878 Church's Map of Antigonish County.

Geological Survey of Canada
1985 Geological Map of the Antigonish Highlands 1982 -5. (PANS Geological Filing Cabinet).

MacDonald, J.W.
1876 History of Antigonish County. Antigonish: Formac Limited. (PANS F5248 A613 M135).

References Cited

Anonymous

"History of the County of Antigonish". (PANS Nova Scotia Scrapbook MG 9 Vol. 37).

MacDonald, J.W.

1876 History of Antigonish County. Antigonish: Formac Limited. (PANS F5248 A613 M135).

Nova Scotia Museum

1996 The Natural History of Nova Scotia, Volume 2: Theme Regions. Halifax: Nimbus.

APPENDIX G

WETLAND EVALUATION

APPENDIX G – WETLAND ANALYSIS

Are Criteria Present?
Choices = Yes (Y), Likely (L), Possibly (P), No (N), Unknown (U)
Level of Criterion Significance:
Choices = National (N), Provincial (P), Regional (R), Local (L), Negligible (NE)
Expected Impact of Project Upon Wetland Values:
Choices = High (H), Moderate (M), Low (L)

LIFE-SUPPORT VALUES

Hydrological Values: Value of the wetland in contributing to surface and groundwater stocks.

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
*Does the wetland contribute to recharge of regional water supply?	N			The wetland is at the bottom of a watershed
*Does the wetland provide flood protection benefits?	Y	L	L	There is only minor displacement of flood water
Does the wetland contribute to usable surface water?	P	L	L	The wetland is a small proportion of Antigonish Harbour
Does the wetland provide erosion control?	N			
Does the wetland provide flow augmentation to users through a headwater position in the catchment basin?	N			
*Does the wetland reduce tidal impacts?	Y	L	L	There is only minor displacement of tidal water
***Critical Value Totals**	2			

Biogeochemical Value: Value of the wetland in contributing to surface water and ground-water quality.

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
*Does the wetland receive significant pollution of a type amenable to amelioration by wetlands?	N			There is no indication of pollution.
Does the wetland provide storage for agricultural run-off?	p	L	L	There is a field nearby.
*Does the wetland provide for containment of toxics contained in surface run-off or through discharge flow?	N			
Does the wetland provide for sediment flow stabilization?	N			
Does the wetland have high nutrient levels which support significant wildlife populations?	Y	R	L	The wetland is an important feeding area for birds and fish
***Critical Value Totals**	0			

Habitat Value: Role of the wetland in contributing to the well-being of important plant and animal values.

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
*Are there any rare, threatened or endangered animal or plant species present?	P	P	L	Nelson's sharp-tailed sparrow has cautionary status by DNR
Does the wetland provide habitat for sport and/or commercial fish?	Y	R	L	Important fish species migrate through the area.

Does the wetland provide significant habitat for reptiles and amphibians?	N			
Does the wetland provide significant habitat for crustaceans?	P	R	L	Mix of salt and freshwater provides an unusual habitat
Does the wetland provide significant habitat for mammals?	P	L	L	Not much known about mammals occurring in the South River area.
*Does the wetland support a significant animal or plant species in unusual abundance?	N			Typical of Northumberland Strait tributaries
Does the wetland and its associated vegetation protect natural shorelines?	P	L	L	Wetland forms shoreline of back and main channels
*Is the wetland ranked as a Class I, II, or III wetland by Canada Land Inventory or other accepted evaluation system?	N			
***Critical Value Totals**	1			

Ecological Values: Role of the wetland in stimulating relations of plant and animal communities.

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
Does the wetland support an extensive ecosystem including uplands?	N			
*Has a regional threshold been reached where the significance of wetland ecosystems for the entire region will be com-promised by further degradation?	N			
*Is the wetland considered a classic example of its type?	N			The wetland is already affected by the existing highway
Are there few remaining natural, unimpacted wetlands of this type in the region?	N			
Does the wetland contain, owe its existence to, or is it a part of or ecologically associated with, a geological feature which is an excellent representation of its type?	N			
Does the wetland form an integral part of an important water drainage system?	N			
*Does the wetland display biological diversity that is of interest?	Y			A mix of salt and freshwater increases diversity
***Critical Value Totals**	1			

SOCIAL/CULTURAL VALUES

Aesthetic Values: Role of the wetland in the quality of the scenic environment.

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
Is the wetland visible from a provincial/ territorial highway, a designated scenic highway/road or passenger railroad?	Y	P	L	Minimal effect on view
Does the wetland provide a valuable aesthetic or open space function?	Y	L	L	
Does the wetland add substantially to the visual diversity of the landscape?	Y	L	L	
*Is the wetland an important sightseeing locale?	N			
***Critical Value Totals**	**0**			

Recreational Values: Role of the wetland in stimulating recreational activities.

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
Does the wetland provide a base for viewing or photographing large numbers of wildlife?	P	L	L	Good access increases the potential
Does the wetland provide opportunities for boating?	Y	L	L	Canoeing
Does the wetland provide winter recreation opportunities?	N			
Does the wetland provide high quality sport hunting or	Y	R	L	Low impact as long as construction avoids

fishing?				angling activity
***Critical Value Totals**	0			

Education and Public Awareness Values: Role of the wetland in stimulating public values and understanding

	Criteria Present?	**Level Criterion**	**Expected Impact**	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
Is the wetland used for scientific research?	N			
*Is the wetland used for educational and interpretation purposes?	N			
Does the wetland exist close to a large urban population?	Y	L	L	Antigonish is 6 km west of the marsh
Does the wetland receive large numbers of visitors?	N			
***Critical Value Totals**	0			

Public Status Values: Role of the wetland in creating a sense of public ownership.

	Criteria Present?	**Level Criterion**	**Expected Impact**	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
Is the wetland part of the pattern of settlement and rural/urban lifestyle?	N			
Is the wetland a designated site of special public interest?	N			

Public Status Values (continued)

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
*Is the wetland a unique national, provincial or regional resource?	N			
Does the wetland provide for easy public access?	Y	L	L	The marsh is located close to Highway 104
Is the wetland public land?	N			
***Critical Value Totals**	0			

Cultural Attribute Values: Role of the wetland in the identity of the people in the area.

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
Does the wetland form part of the historical/ cultural heritage of the regional population?	Y	R	L	Rivers and estuaries were important historic/ cultural features
*Does the wetland contain archeological or paleontological resources?	N			A 19th century graveyard is located outside of the study area.
Is the wetland utilized for cultural events or cultural renewal?	N			
*Does the wetland form part of a native traditional use area?	P	L	L	A native food fishery could use the area.
***Critical Value Totals**	0			

WETLAND PRODUCTION VALUES

Agricultural Values: Role of the wetland in contributing to agricultural production

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
Does the wetland provide water for livestock?	N			
Does the wetland provide a source of forage?	N			
*Does the wetland provide a source of water for crop irrigation?	N			
Does the wetland serve to reduce topsoil erosion?	N			
Does the wetland serve to increase soil moisture and enhance agricultural crop production?	N			
***Critical Value Totals**	0			

Renewable Resource Values: Role of the wetland in contributing to the viability of renewable resource harvest.

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
*Is the wetland used for commercial or subsistence hunting, trapping and fishing?	P	L	L	The wetland could be used by first Nations
Does the wetland provide opportunities for non-commercial uses of fish, wildlife, crustacean and/ or water resources?	Y	L	L	Opportunities are present for non-commercial fishing and trapping in the wetland
Can forest resources of the wetland be harvested?	N			
*Are there other commercial uses of the wetland, such as har-vesting opportunities for wild rice, cranberries, or gathering crabs and oysters?	N			
***Critical Value Totals**	0			

Non-renewable Resource Values: Role of the wetland in contributing non-renewable resources for consumption

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
*Is the wetland used as a commercial source of peat for horticulture or energy?	N			
Does the wetland occur over known mineral or gas and oil deposits?	N			
***Critical Value Totals**	0			

Tourism and Recreational Values: Role of the wetland in stimulating tourism and recreation economic benefits

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
*Does the wetland represent an important local, regional, or provincial tourism or recreation attraction?	Y	R	L	Fishery
Does the wetland contribute to the local, regional, or provincial tourism and recreation economy?	Y	R	L	Through purchase of equipment
Does the wetland contribute to national and international tourism development?	N			
***Critical Value Totals**	1			

Urban Values: Role of the wetland in contributing to urban economic values.

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
*Is the wetland used to provide water for industry?	N			
*Is the wetland used as a means of sewage treatment?	N			
*Is the wetland a direct source of domestic water supply	N			
Does the wetland enhance residential, commercial or industrial development values?	N			
Does the wetland contribute to urban flood protection and associated land values?	N			
***Critical Value Totals**	0			

PROJECT BENEFITS

Employment Benefits: Role of the project in stimulating Job Benefits

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
*Will the project stimulate new employment opportunities or stabilize existing employment levels in the region?	Y	R	L	
Will the project provide for high income jobs?	N			
Will the project stimulate employment upgrading?	N			
Will the project stimulate additional research and educational spin-offs?	N			
***Critical Value Totals**	1			

Economic Benefits: Role of the project in stimulating economic benefits.

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
Will the construction of the project stimulate the local and regional economy	P	R	L	The project will be short-term only
*Will the operation of the project stimulate the local and regional economy?	N			
Will the operation of the project stimulate value-added production to the provincial or national economy?	N			
Will the project generate significant	N			

new taxes and/or enhance the tax base?				
***Critical Value Totals**	0			

Production Benefits: Role of the project in enhancing training opportunities.

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
Will the project stimulate agricultural production?	N			
Will the project stimulate forest production?	N			
Will the project stimulate energy production?	N			
Will the project stimulate tourism and recreational benefits?	P	R	L	
Will the project stimulate manufacturing production?	N			
Will the project stimulate other production?	N			
***Critical Value Totals**	0			

Urban/Industrial Infrastructure Development: Role of the project in enhancing urban/industrial development.

	Criteria Present?	Level Criterion	Expected Impact	Describe Function
	Y, L, P, N, U	N, P, R, L, NE	H, M, L	Provide Highlights Only
Will the project provide accommodation and ease housing shortages?	N			
Will the project facilitate a major transport link for the region?	Y	N	M	Most benefits are not restricted to this site.
Will the project provide a harbour for the region?	N			
Will the project solve regional waste disposal problems?	N			
Will the project provide an alternate location for infrastructure which in incompatible with the urban built-up areas?	N			
***Critical Value Totals**	0			

TERMS OF REFERENCE

NOVA SCOTIA

Department of Finance
Procurement Branch - Public Tenders Office

6176 Young Street
Suite 100
Halifax, Nova Scotia
B3K 2A6

Telephone (902) 424-3333
Facsimile (902) 424-0608

REQUEST FOR PROPOSAL
For
Highway 104 Antigonish, South River Impact Study
Department of Transportation and Public Works
Tender No. 60076691

Request for Proposal Issue Date: *August 23, 2000*

Responses to this Request for Proposal must be Received in the Office of:
Public Tenders Office, 6176 Young Street, Halifax, N.S., B3K 2A6

Not later than
Closing Date and Time: *September 6, 2000; 10:00am, local time*
Public Opening: *September 6, 2000; 10:30am, local time*

Department Contact:
Michael Croft, P.Eng.
Tel. (902)424-3548
Fax. (902)424-0571

Facsimile bids **will not** be accepted

If conflicting information occurs between this page and the remainder of the document, this page is considered correct

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APPENDIX “A” 11

1.0 Background

Highway 104 from Antigonish to Lower South River currently experiences poor levels of service during peak traffic flow and relatively high accidents rates. In order to improve traffic flow and safety in this area a planning study was initiated several years ago to identify and preserve a corridor for a new Highway 104 alignment from Antigonish to Lower South River. The design standard selected for this new highway is a rural freeway divided with a 22.6m wide median, design speed of 120km/hr, and grade separated access.

The planning process to date has included an environmental screening, identification of corridors, functional design of alignment options, public consultations, and various studies including a safety review of alignment options and a peer assessment of TPW's highway planning process. Three alignment options, commonly referred to as Brown, Red, and Blue, were considered for the routing of the proposed Highway 104. After evaluation of numerous impact factors the Blue Route was approved for environmental assessment registration.

Because of the project's size it must be registered as a Class 2 undertaking with the Nova Scotia Department of Environment (DOE) and undergo a full Environmental Assessment (EA). Also, due to anticipated Federal cost sharing, this project is subject to the requirements of the Canadian Environmental Assessment Act (CEAA) and must receive Federal environmental approval.

South River is located approximately 6km east of the Town of Antigonish. The recommended Blue Route crosses South River just downstream of the existing Highway 104. The river at this location is a salt marsh which supports an abundance and variety of fish, birds, and other wildlife. Potential impacts to this section of the South River were identified as a major concern during the environmental screening and peer assessment.

The consultant conducting the peer assessment recommended a realignment of the Blue Route be considered. A study of alternative routes across the South River was conducted and only one feasible realignment was identified that avoids the salt marsh. This realignment, however, has significant deficiencies related to design characteristics, safety, and access considerations that, based on information available to date, appear to outweigh the potential negative environmental impacts of the Blue Route.

Although the proposed Blue Route through South River was approved by TPW, there are significant concerns regarding the environmental impacts of the Blue Route at the South River crossing. Due to these concerns it has been decided to conduct a detailed analysis of the Blue Route South River crossing, prior to environmental registration with DOE, to determine the magnitude and extent of environment impacts at the South River crossing, what mitigation measures will be required, and the cost implications.

2.0 Objective

The primary objectives of this study are to:

1. Identify the environmental impacts of the recommended Blue Route on South River including the salt marsh habitat.

2. Identify any previously undetected avoidance constraints within the study area that may force realignment of the recommended Blue Route.

3. Determine environmental and other mitigation measures required at the South River crossing including associated costs.

4. Determine the general configuration of the structures (two 2-lane structures) at South River including preliminary cost estimates.

3.0 Study Area

The geographic extent of the study area is generally defined as a 200m wide corridor, centered along the recommended Blue Route, extending from 200m west of South River to 200m east of South River. The Study Area is shown on Figure 1. This Study Area is intended to indicate the limits within which the proposed alignment may move, and should be used for **site specific criteria only**. Many criteria to be investigated as part of this study will have areas of potential impact outside this Study Area, and the Consultant should use their judgement and expertise to develop these impact areas.

4.0 Scope of Work

The Scope of Work is defined in attached Appendix A.

5.0 Duties of the Consultant

-Meet with the Project Management Team as per the schedule specified in Section 8.0 (Meetings and Reports).

-Become familiar with the study area, environmental elements, and concerns.

-Review existing information regarding the proposed alignment and any relevant studies previously conducted.

-Contact landowners regarding accessing their property to conduct field work.

- Liaise directly with the appropriate authorities in the performance of the work including local officials with the Department of Natural Resources, Department of Environment, and the Department of Fisheries and Oceans

-Conduct required field work, research and analysis.

-Identify preventive, mitigative or avoidance measures that will be required as a result of the proposed undertaking and associated costs.

-Identify additional regulatory approvals or permits that may be required prior to construction of the proposed highway.

- Prepare preliminary structural designs (general arrangement) including costs estimates.

- Provide recommendations/conclusions

6.0 Duties of TPW

- Meet with the consultant on an arranged schedule.

- Provide the consultant with any required documentation (reports, studies, plans, etc.) related to the project.

7.0 Guidance

A project management team will administer the technical and analytical work of the consultant. The team will consist of representatives from TPW . The consultant will report to the project management team chair who will be responsible for overall administration of the study.

Acceptance and approval of the work will take place after the project management team has been satisfied that the requirements, as specified in the contract, have been met.

8.0 Meetings and Reports

The Consultant shall meet with the project management team for the project initiation, the draft final report review, and other meetings as required during the duration of the project. All meetings will be held in Halifax, Nova Scotia. The consultant shall meet with the project management team within two weeks of notification of award of contract. The initial meeting with the consultant will be to finalize the study requirements, data requirements and the methodologies to be used.

The following reports shall be required:

Three (3) copies of a draft final report for the Study must be submitted for comment and possible amendments before the final version is submitted. The Consultant must be prepared to submit a second draft if requested. Required copies of the draft final report shall be submitted 5 working days prior to the review meeting.

Ten (10) bound copies and one unbound copy of the final report. The Consultant shall also have a copy on hand should additional copies be required at short notice. All copies of the draft and final report shall be on letter size paper and appropriately titled. The final report shall include an executive summary and a list of references. All reports shall contain copies of supporting plans and figures. The Terms of Reference shall be attached as an appendix to the final report.

9.0 Study Schedule

The consultant shall meet with the project management team within two weeks of notification of award of contract. The study shall be completed and the required copies of the final report presented within four (4) months of award of contract.

10.0 Ownership of Information

The consultant agrees that all information collected, materials gathered and reports produced shall be the property of the Province of Nova Scotia. The consultant shall not be permitted to publish or in any way use said information without the expression or prior approval of TPW.

All documents, including proposals, submitted to the Province are subject to disclosure under the Nova Scotia Freedom of Information and Protection of Privacy Act. By submitting a proposal the proponent thereby agrees to public disclosure of its contents. Any information the proponent considers 'personal information' because of its proprietary nature should be marked as "confidential", and will be subject to appropriate consideration as defined within the Nova Scotia Freedom of Information and Protection of Privacy Act.

Information pertaining to this competition or any Department obtained by the proponent as a result of participation in this project is confidential and must not be disclosed without written authorization from the Province.

11.0 Consultant Expertise/Eligibility

Project teams should have considerable expertise in environmental assessments in general and in the various issues/elements under consideration in this Study, in particular. As a minimum, the project team must contain a structural engineer experienced in bridge design, a hydrologist, a hydrogeologist, an archaeologist eligible to practice in Nova Scotia, and biologists specializing in wetlands, habitat assessment, and identifying rare and endangered species. The engineering principal shall be a registered member of the Association of Professional Engineers of Nova Scotia (APENS).

Prospective proponents are not eligible to submit a proposal if current or past corporate or other interests may, in the Province's opinion, give rise to a conflict of interest in connection with this project.

The successful proponent may be required to demonstrate financial stability and may be required to register to conduct business in Nova Scotia.

Occupational Health and Safety

Professional Liability
$2 mill
General $5 mill.

The contracted party must have either a Certificate of Recognition issued jointly by the Nova Scotia Department of Labour and an occupational health and safety organization approved by Nova Scotia Department of Labour, or the contracted party must have a Letter of Good Standing from an occupational health and safety organization approved by Nova Scotia Transportation and Public Works indicating that the contracted party is in the process of qualifying for the Certificate of Recognition.

The successful bidder will be expected to develop a safety plan for the project, to be reviewed by TPW. This plan must deal with hazard recognition, assessment and control, provision of first aid services, and handling of emergencies and it must meet all requirements prescribed by the Occupational Health and Safety Act and regulations.

Workers Compensation

The successful bidder must provide proof that they have either:
i) Registered with the Workers' Compensation Board and are in good standing (for at least the duration of this project), or
ii) Received a letter from the Workers' Compensation Board stating that the type of work they are undertaking does not meet their criteria for required coverage.

12.0 Proposal Requirements

Failure to provide information outlined in this section may result in disqulification.

Four (4) copies of your proposal (fax copies are not acceptable) are to be delivered by 10:00 am local time, September 6, 2000 to;

Public Tenders Office
6176 Young Street, Suite 100
Halifax Nova Scotia
B3K 2A6
Tender 60061440

Proposals and their envelopes should be clearly marked with the name and address of the proponent, the Request for Proposal number, and the project or program title. A public opening will be held on September 6, 2000 at 10:30 am local time at the Public Tenders Office. Late proposals will not be accepted and will be returned to the proponent.

Proponents are solely responsible for their own expenses in preparing, delivering or presenting a proposal and for subsequent negotiations with the Province, if any. Proposals must be open for acceptance for at least **90** days after the closing date. Upon acceptance, prices will be firm for the entire contract period unless otherwise specified.

To facilitate efficient review of the proposals, proponents are requested to use the following format. The proposal shall be organized into four chapters and such chapters limited where indicated.

1 Introduction

This chapter shall include, but not necessarily be limited to, background information, a description of the study area, and understanding of the project and its objectives, including potential key issues.

2 Qualifications

This chapter shall include, but not necessarily be limited to, company/companies corporate profile, client references, and the proposed team members. Corporate information not relevant to the proposed project is not necessary, however may be included in an Appendix if the Consultant feels it appropriate.

A summary of relevant company experience. This shall be a maximum of three pages.

A summary of project team member experience in areas related to these terms of reference. This summary shall be a maximum of one page per team member, focussing on the team member's relevant experience and expected contribution to the project. Curricula vitae of team members, preferably outlining only relevant experience, shall be included in an Appendix.

3 Methodology

This chapter shall include, but not necessarily be limited to:

A list of all information and data sources available to the Consultant and expected to be used in the Study.

A detailed work plan, identifying planned field work, and including intended approach, methodology and schedule for the study. See Appendix A for required work.

A draft table of contents for the report.

A concordance table (or similar) linking proposal to this RFP.

4 Project Management

This chapter shall include, but not necessarily be limited to, a discussion of quality assurance/quality control, cost control, scheduling, insurance, and safety certification. Copies of certificates are not required as part of the proposal, but shall be provided by the successful Consultant upon award of the contract.

Number of person-days for each team member by task assigned to the project. For consistency, the basis of remuneration will be per **8 hour day** for all team members.

One copy of the cost proposal shall be provided, **to be separately sealed in an envelope,**

including labour costs, related expenses, printing costs and professional services obtained outside of the firm. In order to assess level of effort, time commitments for all team members (**excluding labour costs**) shall be included in the main body of the proposal. Prices quoted are to be in Canadian dollars and **exclusive of federal and provincial taxes**. Expenses shall not exceed the Nova Scotia provincial rates ($0.315/km, breakfast $6.00, lunch $7.00, supper $13.50, incidentals $4.00 per night)

By submitting a proposal, the proponent warrants that all components required to deliver the services requested have been identified in the proposal or will be provided by the Consultant at no additional charge. The proposal must be signed by the person(s) authorized to sign on behalf of the proponent and to bind the proponent to statements made in response to this Request for Proposal.

13.0 Liability for Errors

While considerable effort to ensure the accuracy of the information in this Request for Proposal has been made, the information contained in this Request for Proposal is supplied solely as a guideline to Proponents. The information is not guaranteed or warranted, nor is it necessarily comprehensive or exhaustive.

14.0 Extra Work

The consultant may be required to undertake additional work not specified in the contract. Prior to starting this additional work the consultant shall submit a detailed breakdown of the costs, including all expenses, to complete the extra work and obtain written approval from the project management team.

15.0 Request for Proposal Amendments

All proponents will be notified by the Public Tenders Office regarding any changes made to the Request for Proposal or any appendices or any change in the closing date or time. When these changes occur within **five** government business days of the close of the proposal, the proposal closing date will be extended to allow for a suitable number of bid preparation days between the issuance of the change and the closing date. All amendments must accompany each proposal. Proposals that do not contain all the amendments will be immediately returned and the proponent eliminated from further consideration.

16.0 Payment Schedule

Payments for professional services rendered will be made monthly in arrears upon receipt of invoices detailing progress work completed, and subject to the following conditions;

(a) Monthly payments will be issued for up to 90 % of the amount invoiced. The remaining amount will be paid upon completion of and acceptance of the work, as indicated in (b), and;

(b) The total of such payments is not to exceed 80% of the fixed price for the contract. The remaining 20% will be paid upon acceptance of the final report by the project management team.

(c) Receipts shall be provided for all expenses if requested.

The consultant is expected to provide a level of service consistent within a budget of **$30,000**.

17.0 Evaluation of Proposals

Proposals shall be evaluated based on the "Government Procurement Process: Architects and Professional Services" (June 15, 1998).

All proposals will be initially assessed based on the experience and expertise of the project team. Any proposals not meeting minimum qualifications will not be evaluated further.

The criteria for evaluating proposals, based on technical and managerial merit, will be the following;

- Experience and expertise of the consulting firm on similar projects.	5 points
- Qualification and experience of team members on similar projects.	20 points
- Understanding of project and objectives.	20 points
- Proposed methodology and approach.	20 points
- Quality of the proposal/level of effort.	15 points
- Local knowledge and content.	5 points

After meeting initial qualifications, proposals will be evaluated on the basis of their technical and managerial merit and then on the basis of price. The technical submission shall be rated as shown above, out of 85 points, and the remaining 15 points shall be allotted based on price. Only those proposals achieving an aggregate score of 68/85 (80%) or greater will have their sealed cost envelopes opened. The lowest price shall be awarded 15 points (all prices within 5% will receive the same price points). The next lowest price (beyond 5%) will receive 12 points. Points for other submissions will be assigned with 3 fewer points for each successively higher priced price proposal. But again, each time the same score will be awarded if successive prices are within 5% of the last highest price. The proposal with the highest total points will be awarded the contract. Proposals not meeting the required 68/85 will have their unopened cost envelopes returned.

Not withstanding the technical/managerial and price scores TPW reserves the right to reject any proposal where prices are deemed unreasonable relative to other prices bid, typically a 25% variance from the average qualified bid (excluding the bid in question).

TPW reserves the right to negotiate any or all conditions of the consultant's proposed work plan and reject all submitted proposals. Unsuccessful proponents may request a debriefing meeting following execution of a contract with the successful proponent.

18.0 Contract Procedures

Notice in writing to a proponent of the acceptance of its proposal by the Province and the subsequent full execution of a written contract will constitute a contract for the goods or services, and no proponent will acquire any legal or equitable rights or privileges relative to the goods or services until the occurrence of **both** such events.

If a written contract cannot be negotiated within **thirty** days of notification of the successful proponent, the Province may, at its sole discretion at any time thereafter, terminate negotiations with that proponent and either negotiate a contract with the next qualified proponent or choose to terminate the Request for Proposal process and not enter into a contract with any of the proponents.

19.0 Inquiries

All enquiries related to this Request for Proposal are to be directed to the following person. Information obtained from any other source is not official and may be inaccurate. Enquiries and responses may be recorded and may be distributed to all proponents at the Province's option.

Department Contact:	Michael Croft, P.Eng. (Project Management Team Chair) Infrastructure Planning Engineer Telephone: 902-424-3548 Fax: 902-424-0571 Email: croftmi@gov.ns.ca

Appendix A
Scope of Work

- Provide a general description of the project as it is planned to progress through the construction and operational phases with emphasis on the section through the study area.

- Provide a general description of the existing terrain within and adjacent to the study area including a discussion of the area affected by the undertaking and the sensitive aspects of the biophysical environment that may be adversely affected by the project. The description shall include, but not necessarily be limited to, area geography, existing and anticipated land use, atmospheric conditions, ambient noise levels, surface water (hydrological, hydraulic, water quality, drainage areas, etc.), groundwater (hydrogeological and water quality), valued environmental components, habitat identification (flora, bird, fish and terrestrial fauna), bedrock and surficial geology, archaeological sites, transportation, and regulatory environment.

- Conduct field work, research and analysis required to identify and predict the magnitude and importance of project impacts, both positive and negative, on the bio-physical environment and archaeological resources. This analysis shall also include an investigation of the current use of lands and resources for traditional purposes by aboriginal persons. Field work shall include, but not necessarily be limited to, flora and fauna surveys (including migratory birds), fish habitat evaluation (including abundance, distribution, and composition of fish species), archaeological surveys, and subsurface testing to determine bedrock geology (the presence of karst terrain is a major concern) and soil characteristics. The cumulative effects of this project together with past projects, such as the existing Highway 104 structure at South River, and potential future projects within the study area shall be considered.

Any wetlands that are adversely affected by the Undertaking are to be evaluated according to the 1995 Nova Scotia Department of the Environment Wetlands Directive; or the North American Wetlands Conservation Council (Canada) Wetland Evaluation Guide or an equivalent process acceptable to the Nova Scotia Department of the Environment.

Assessment of impacts of the South River structure shall include a.) an estimate of the area of salt marsh, estuary channel, and main channel within the structure's footprint (approaches, piers, and abutments) b.) timing considerations for construction work with respect to fisheries, wildlife, and migratory bird windows, c.) access considerations for construction of the structure, d.) potential requirements under the Navigable Waters Protection Act.

- Provide a detailed description of those measures that will be required to prevent or minimize adverse impacts on the environment including a description of appropriate compensation that could be provided when environmental damage is unavoidable. This section shall include, but not necessarily be limited to, required mitigation measures related to regulatory compliance, dust and airborne pollution control, accidental spills, noise, surface water quality, fish habitat, groundwater quantity and quality, storm water runoff, erosion and sedimentation control, acid producing bedrock, disturbance of contaminated soil, impacts of contaminated groundwater, impacts to flora (in particular any rare or endangered species), impacts to terrestrial and aquatic fauna, migratory bird habitat, and archaeological resources.

Both approaches to the proposed crossing are over moderately steep terrain and in areas of highly erodible clay soils. Particular attention is required to the assessment of potentially complex sediment and erosion control measures required to protect the South River during construction.

- Identify additional regulatory approvals or permits that may be required prior to construction within the study area.

- Prepare general arrangement designs for the two structures at the South River crossing including order of magnitude cost estimates based on TPW design standards (preliminary discussions with DFO indicate a complete spanning of the back channel and retention of the maximum area of salt marsh will be required). Subsurface investigations shall be conducted as required to determine general foundation design requirements at abutments and piers.

APPENDIX F

FEDERAL COORDINATION REGULATIONS CORRESPONDENCE

Canadian Environmental Assessment Agency
TD Centre
Suite 1030
1791 Barrington Street
Halifax, Nova Scotia
B3J 3L1

Agence canadienne d'évaluation environnementale
Centre TD
Bureau 1030
1791, rue Barrington
Halifax (Nouvelle Écosse)
B3J 3L1

RECEIVED
ENVIRONMENTAL SERVICES
NOV 9 2001
NOVA SCOTIA Department of Transportation & Public Works

November 6, 2001

Elizabeth Pugh, P. Eng.
Nova Scotia Department of
Transportation & Public Works
P.O. Box 186
Halifax, Nova Scotia
B3J 2N2

Dear Ms. Pugh:

RE: FEDERAL COORDINATION REGULATION
HIGHWAY 104 AT ANTIGONISH

On September 12, 2001, the project description for the captioned project was distributed to Transport Canada, Environment Canada and DFO in accordance with the requirements of the Federal Coordination Regulations.

All departments have now responded with the following determinations:

DEPARTMENT	RESPONSE
Transport Canada	Likely to require an environmental assessment
Environment Canada	Not likely to require an environmental assessment
Fisheries and Oceans - CCG	Likely to require an environmental assessment
Fisheries and Oceans - Habitat	Likely to require an environmental assessment

…/2

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It is suggested that you invite Transport Canada, Environment Canada and DFO to provide expert advice pertaining to their mandates during the preparation of terms of reference and subsequent steps in the environmental assessment process.

Please advise if you wish to discuss further.

Yours truly,

per P.

W.A. Coulter, P. Eng.
Regional Director

cc: Regent Dickey, P. Eng., Transport Canada
Ian McCracken, Environment Canada
James Leadbetter, DFO - Habitat
Jon Prentiss, DFO - Canadian Coast Guard
Chris Daley, NSDOEL

encl: Letter and attachment - Jim Leadbetter to Bill Coulter, October 10, 2001
Letter - Ian McCracken to Bill Coulter, September 24, 2001

Nombre de pages: 2

Programs and Divestiture
Programmes et Cessions

FACSIMILE TRANSMITTAL FORM
POUR TÉLÉCOPIEUR

BORDEREAU DE TRANSMISSION

TRANSMITTED FROM TRANSPORT CANADA, OTTAWA TRANSMIS DE TRANSPORTS CANADA, OTTAWA	FAX: (613) 990-9639 TÉLÉC: Date : 17 October 2001	VERIFICATION: VÉRIFICATION:

TO: Bill Coulter
À: CEAA

NUMÉRO DE TÉLÉCOPIEUR: (902) 246-6550
FAX NUMBER:

FROM/DE: Régent Dickey

TELEPHONE NO.: (613) 991-6452

SPECIAL INSTRUCTIONS - INSTRUCTION SPÉCIALES

Bill,

Please find reply to your Federal Coordination Regulations on project Highway 104 at Antigonish. As per our last meeting, TC will act as AR. No formal request for the province is yet received to fund this project under Fed/Pro. Agreement. If you have any question please do not hesitate to call me at (613) 292-8442. Regards

Regent Dickey
Surface Program

CEAA / ACEE
RECEIVED
OCT 29 2001
ATLANTIC REGION
2001-501

FEDERAL COORDINATION REGULATIONS
Sections 4 & 6
RECORD OF DETERMINATION

HIGHWAY 104 AT ANTIGONISH - NOVA SCOTIA

FEDERAL AUTHORITY: TRANSPORT CANADA
NAME & TITLE: REGENT DICKEY, HWY AGREEMENT MGT
SIGNATURE: Regent Dickey DATE: 11 / 10 / 200
dd / mm / yy

Is your Department / Agency:

(a) **likely** to require an environmental assessment of the project ☑

(b) **not likely** to require an environmental assessment of the project ☐

(c) **in possession** of specialist or expert information or knowledge that is necessary to conduct the environmental assessment of the project ☐

Does your Department / Agency

(d) require additional information to make a determination under items (a), (b) or (c) ☐

If the answer to (a) is "yes"

- Indicate the "trigger" under section 5 of the *Canadian Environmental Assessment Act*

Trigger: likely to fund this project through Fed/Prov Agr.

- Identify the contact person for the environmental assessment if different from above.

Name & Title:
Address:
Telephone/Fax:
e-mail:

If the answer to (d) is "yes", the Regulations require that the additional information be requested within 10 days after making the determination.

Please return by fax to:
CANADIAN ENVIRONMENTAL ASSESSMENT AGENCY
Fax Number: (902) 426-6550

Environmental Protection Branch
16th Floor, Queen Square
45 Alderney Drive
Dartmouth, NS B2Y 2N6

CEAA / ACEE
RECEIVED
SEP 28 2001
ATLANTIC REGION

File No.: 4194-82/2
Data File: C:\BARB\EA Corresp\2001\2001-291.doc

September 24, 2001

2001-437.

Bill Coulter
Regional Director
Canadian Environmental Assessment Agency
TD Centre Suite 1030
1791 Barrington Street
Halifax, NS B3J 3L1

Dear Mr. Coulter:

RE: Project Description: Highway 104 Upgrade EAS 2001-291
Antigonish, NS

Introduction

As requested, staff of Environment Canada (EC) have reviewed the documentation regarding the above-noted project proposal, which was forwarded to our office with your memorandum of September 11, 2001. From the information provided, it is understood that the proponent intends to upgrade Highway 104 near Antigonish by diverting through traffic from a two-lane uncontrolled access roadway to a divided four-lane, controlled access, highway. The proposed alignment, closely paralleling the existing roadway, will extend 15 km between Addington Forks Road and Taylor Road. It is further understood that there is no acid-generating rock in the vicinity of the project.

Determination

Based on the project description, it is not likely that EC has any powers, duties or functions in relation to the proposed project under section 5 of the CEAA, that would require an environmental assessment. However, as indicated below, EC has in its possession specialist knowledge and information which may be of assistance.

Mandate

As you are aware, EC is responsible for administering several statutes such as the *Department of Environment Act*, *Fisheries Act* (Section 36), *Canadian Environmental Protection Act*, *Canada Water Act*, *Canada Wildlife Act*, and the *Migratory Birds Convention Act* which are focussed on promoting sustainable development, protecting the environment, conserving certain renewable resources and reporting on environmental conditions. EC is also the lead federal department in promoting a variety of federal policies and programs concerning the environment including the: Federal Policy on Wetland Conservation; A Wildlife Policy for Canada; Federal Water Policy; Toxic Substances Management Policy; and, Pollution Prevention - A federal strategy for action.

Environment Canada Environnement Canada
Canada

It is understood that a number of studies/investigations will be required to identify and quantify possible project/environment interactions in order to develop mitigative measures and an Environmental Management Plan (Section 6.0). EC supports the proponent's plan to carry out surveys of flora and fauna (which should include species at risk), and migratory birds within the project area, as well as a detailed wetlands impact analysis. In the interest of facilitating the timely exchange of information and early attention to issues of particular concern to EC, the following preliminary guidance is offered. It is requested that this guidance be conveyed to the proponent in the anticipation of the need for an environmental assessment that reflects both federal and provincial requirements.

Preliminary Review Comments

EC Legislation and Policies

Based on EC's understanding of the project description, the following departmental legislation and policies are highlighted. The proponent should describe measures that are being taken to ensure compliance with the legislation, as well as those that demonstrate consideration of pertinent environmental policies.

1. *Fisheries Act* (Section 36)
   - the deposit of a deleterious substance into waters frequented by fish is prohibited.

2. *Canadian Environmental Protection Act*
   - regulations, notices, codes of practice, guidelines (e.g. Canadian Environmental Quality Guidelines (1999)) and priority substance assessment program (http://www.ec.gc.ca/CEPARegistry/regulations/).

3. *Migratory Birds Convention Act* and associated Regulations

   - Migratory birds, their eggs, nests and young are protected under the Act and Regulations (Migratory birds include those species listed in the Canadian Wildlife Service Occasional Paper No. 1 "Birds Protected in Canada under the Migratory Birds Convention Act" (1991). The Act and regulations include the following prohibitions:

     - "no person shall disturb, destroy or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird" without a permit;

     - "no person shall deposit or permit to be deposited oil, oil wastes or any other substance harmful to migratory birds in any waters or any area frequented by migratory birds".

   Relevant Environmental Assessment Guidelines (http://www.ec.gc.ca/guide_e.html)
   - Migratory Birds Environmental Assessment Guideline (1998)
   - Environmental Assessment Guideline for Forest Habitat of Migratory Birds (1998).

4. Federal Policy on Wetland Conservation and associated Implementation Guide for Federal Land Managers (http://www.cws-scf.ec.gc.ca/public_e.html).

   - In support of the objective of "promoting the conservation of Canada's wetlands to sustain their ecological and socio-economic functions, now and in the future", the Federal Government strives for the goal of **No Net Loss of wetland function on federal lands or when federal funding is provided**. No Net Loss can be achieved by following a hierarchical sequence of mitigation alternatives: avoidance, minimization and compensation. The best and least disruptive approach to mitigation of environmental effects is impact avoidance. Avoidance refers to elimination of adverse effects on wetland functions, by altering the siting or the design of a project. Minimization refers the reduction or control of adverse effects via modification of the project or implementation under special conditions. Compensation refers to the replacement of unavoidably lost wetland functions, through enhancement of existing wetlands, or, as a last resort, creation of new wetlands.

Relevant Environmental Assessment Guideline (http://www.ec.gc.ca/guide_e.html)

- Wetlands Environmental Assessment Guideline (1998).

5. Species at Risk

   - Information on species at risk in the general project area can be obtained from the following sources:
     - Atlantic Canada Conservation Data Centre (contact Stefen Gerriets at 506-364-2657 or sgerriets@mta.ca)
     - Committee on the Status of Endangered Wildlife in Canada (http://www.speciesatrisk.gc.ca)
     - Nova Scotia Museum of Natural History and the Nova Scotia Department of Natural Resources.

6. Pollution Prevention - A Federal Strategy for Action (http://www.ec.gc.ca/pollution/strategy/en/p4.cfm)

   - Pollution prevention can be defined as the use of processes, practices, materials, products or energy that avoid or minimize the creation of pollutants and waste, and reduce overall risk to human health or the environment.

Issues of Concern to Environment Canada

The following issues should be addressed in an environmental assessment of this project:

Meteorological and hydrological influences on the project
(e.g. sizing of culverts and other structures at two major and several minor water crossings)

- sensitivity of the project to variations in meteorological and hydrological conditions including extreme events;
- potential implications of climate change and related effects on the operation, decommissioning or abandonment of the project.

Impacts of effluents and site drainage from all activities associated with the project

- sources, characteristics and estimated quantities of contaminants (e.g. de-icing agents, suspended solids) released to receiving waters;
- changes to the quality of receiving waters taking into account Section 36 of the *Fisheries Act* and the CCME Canadian Environmental Quality Guidelines (as they pertain to the protection of aquatic life);
- changes to the quality of migratory bird habitat and impacts on migratory birds and species at risk (if any).

Impacts of toxic substances

- sources, characteristics and estimated quantities of toxic substances (e.g. products used in the construction, operation and maintenance of the highway);
- probability of an accident or malfunction (e.g. spillage from fuel storage facilities) and consequences of an accident for environmental quality, migratory birds, species at risk and related habitat.

Impacts of land use changes on biodiversity with attention to impacts on migratory birds, species at risk, and their habitats including wetlands

- loss and fragmentation of habitats;
- loss of wetland functions.

Presence of species at risk

- the presence of species at risk in the area should be confirmed by field surveys carried out by professional biologists at the appropriate time of year *in habitats potentially harbouring species at risk.*

(Note: There are inconsistencies in the project description with respect to the presence of species at risk. For example, Section 4.1 states that "there are no known occurrences of rare and/or endangered plant or animal species within the project area". Section 5.1 indicates that "although there are no known rare or endangered plant or animal species within the corridor for the proposed alignment, there are known occurrences within the broader study area". Appendix A suggests that "several species of rare plants and animals exist in the study area".)

Cumulative Effects

- other projects or activities that have been or are likely to be carried out, in addition to the proposed highway project, must be considered where there is a potential for cumulative effects. From EC's perspective, attention to cumulative effects should be focussed on establishing how project-induced effects on ecosystem components (e.g. species at risk, migratory birds, habitats, wetland functions, hydrological regime, environmental quality) would be compounded by other projects and activities impacting these same attributes.

Mitigation and Monitoring

A mitigation and monitoring strategy should be prepared to facilitate management of the identified adverse environmental effects including cumulative environmental effects. Such a strategy should reflect a clear priority on impact avoidance and minimization opportunities (e.g. pollution prevention). A contingency plan that would facilitate a rapid and effective response to an accidental event (e.g. spill, malfunction) should also be an integral part of a mitigation and monitoring strategy.

Provisions for verifying the accuracy of impact predictions, and the effectiveness of mitigation measures, during project implementation should be outlined. The proponent should be prepared to adopt alternative mitigative measures and to take corrective actions accordingly.

Editorial Comments

It should be pointed out that the *Migratory Birds Convention Act* is incorrectly referred to as the *Migratory Birds Conservation Act* in Section 7.0.

I trust the above comments will be of assistance. We look forward to the identification of opportunities to participate in the federal environmental assessment that may be required. In the interim, if you have any questions, please give me a call at (902) 426-9662.

Yours truly,

Ian McCracken

Ian McCracken
Environmental Assessment Science Advisor
Pollution Prevention Division (Atlantic Region)

cc B. Jeffrey
E. Hundert
R. Gautreau

Fisheries and Oceans Canada Coast Guard
Pêches et Océans Canada Garde côtière

NAVIGABLE WATERS PROTECTION / PROTECTION DES EAUX NAVIGABLES
MARITIMES REGION / RÉGION DES MARITIMES

From: Jon Prentiss — Canadian Coast Guard NWP Officer — P.O. Box 1000 Navigable Waters Protection — Dartmouth, Nova Scotia Maritimes Region — B2Y 3Z8	**De:** Jon Prentiss — Garde côtière canadienne Agent LPEN — C.P. 1000 Protection des eaux navigables — Dartmouth, (Nouvelle-Écosse) Région des Maritimes — B2Y 3Z8
Facsimile / Télécopieur (902) 426-7585 Tel. N° / N° De Tél. (902) 426-2714	Email/Courrier électronique prentissj@mar.dfo-mpo.gc.ca
DATE: September 25, 2001	TOTAL NUMBER OF PAGES INCLUDING COVER SHEET/ NOMBRE TOTAL DE PAGES INCLUANT LA COUVERTURE: 2
Your file / Votre référence	Our file / Notre référence 8200-01-2387

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SEP 25 2001
ATLANTIC REGION
2001-429

To/À

Name / Nom	DEST. FACSIMILE N°: / Numéro de FAC-SIMILÉ:	TEL. NO / NO DE TÉL.
CEA Agency	426-6550	
Carol Sampson - DFO	426-1489	426-5132

Re/Sujet: FCR - ROD Highway 104 at Antigonish, N.S.

Please find enclosed ROD for above project.

Should you have any questions, please do not hesitate to contact me.

Signature

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FEDERAL COORDINATION REGULATIONS
Sections 4 & 6
RECORD OF DETERMINATION

HIGHWAY 104 AT ANTIGONISH - NOVA SCOTIA

FEDERAL AUTHORITY: NAVIGABLE WATERS PROTECTION ACT (NWPA)
NAME & TITLE: JON PRENTISS NWP OFFICER
SIGNATURE: DATE: 25 / 09 / 01
dd / mm / yy

Is your Department / Agency:

(a) **likely** to require an environmental assessment of the project ☑

(b) **not likely** to require an environmental assessment of the project ☐

(c) **in possession** of specialist or expert information or knowledge that is necessary to conduct the environmental assessment of the project ☐

Does your Department / Agency

(d) require additional information to make a determination under items (a), (b) or (c) ☐

If the answer to (a) is "yes"

- Indicate the "trigger" under section 5 of the *Canadian Environmental Assessment Act*

Trigger: 5(1)

- Identify the contact person for the environmental assessment if different from above.

Name & Title: HABITAT MANAGEMENT DIVISION - DFO
Address: c/o CAROL SAMPSON - R.I.O.
1 CHALLENGER DRIVE, DARTMOUTH, NS.
Telephone/Fax: P- 426.5132 FAX 426.1489.
e-mail:

If the answer to (d) is "yes", the Regulations require that the additional information be requested within 10 days after making the determination.

Please return by fax to:
CANADIAN ENVIRONMENTAL ASSESSMENT AGENCY
Fax Number: (902) 426-6550

Fisheries and Oceans Canada Pêches et Océans Canada

Habitat Management Division
P.O. Box 1006
B505, 5th Floor
Dartmouth NS
B2Y 4A2

Your file Votre référence

Our file Notre référence
01-G6-109

October 10, 2001

Mr. Bill Coulter, P. Eng.
Regional Director
Canadian Environmental Assessment Agency
Suite 1030 TD Center
Halifax Nova Scotia
B3J 3L1

Dear Mr. Coulter:

RE: Project Description, Highway 104 at Antigonish

This is in response to your letter of September 11, 2001, attached to which was the above projects description and a "Record of Determination" form pursuant to Sections 4 & 6 of the Federal Coordination Regulation (FCR). As per your request our Department has reviewed the project description and completed the FCR form (attached).

The Habitat Management Division (HMD) of the Department of Fisheries and Oceans (DFO) administers sections of the Fisheries Act that can serve as a Law List Trigger under the Canadian Environmental Assessment Act (CEAA).

During our review of the project description it was noted that the proposed highway alignment will either cross or directly impact on the following highly sensitive fisheries watercourses: (1) Briley Brook where structures would be required in the headwater tributaries which are over-wintering areas for Atlantic salmon, trout and other fish species. Briley Brook has been the subject of a highly successful fish habitat restoration project focusing on spawning and rearing habitat for Atlantic salmon and brook trout. There has been an eightfold increase in salmon spawning in Briley Brook since 1992. (2) The West

...2/

River where a major bridge structure would be required. The West River has the highest juvenile Atlantic salmon densities per unit area of any watershed in the Maritimes. The proposed crossing site is also a critical migration route, holding area and fishing area for salmon, trout, gaspereau and other fish species. (3) South River where a major bridge will be required.The South River contains a diverse fishery including Atlantic salmon, sea trout, brown trout, rainbow trout, stripped bass, gaspereau and other fish species. The area north of the existing highway 104 is a highly productive salt marsh critical to both the freshwater and marine fisheries resource.

In addition to sensitive fisheries watercourses being crossed, virtually the entire length of the proposed highway alignment is located on highly eroadable, fine grained, clay/silt soils. The nature of these soils, the volumes of earth which must be moved, the rolling terrain adjacent to the proposed watercourses crossings all greatly increase the potential for adverse effects on the fisheries resource during construction of the highway.

Based on the above our Department has concluded that the above three watercourse crossings and potentially others along the alignment will likely result in the harmful alteration, disruption or destruction of fish habitat (HADD), contrary to section 35(1) of the Fisheries Act which states:

"No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat".

DFO will, therefore, be obligated to ensure an assessment pursuant to the Canadian Environmental Assessment Act (CEAA) is carried out for any of the above watercourse crossings where a HADD is anticipated to occur.

For clarification this letter confirms that based on our review of the project description for the construction of Highway 104 at Antigonish, an Environmental Assessment (EA) is ***likely*** with regard to the Fisheries Act under CEAA. In addition, DFO confirms it is in possession of expert information and knowledge, with respect to the fish and fish habitat, that is necessary to conduct the environmental assessment of this project.

...3/

It should be noted, however, that our Department must reserve our final determination on whether a Fisheries Act Authorization and a supporting CEAA screening will be required on each of the fisheries stream crossings until we have received and reviewed the following: (1) the final design drawings of all watercourse crossing structures; (2) the aquatic study of all watercourse crossings referred to in the project description.

The scope of the CEAA screening(s) for any Fisheries Act Authorization(s) will likely be limited to the watercourse found within the right-of-way and the immediate approach areas.

Thank your for the opportunity to review and comment on this proposal.

If your have any questions with respect to these comments please contact me at (902) 426-6027.

Sincerely,

James Leadbetter

James Leadbetter
Evaluation and Mitigation
Habitat Management Division
Maritimes Region

cc: C..MacInnis
E. Pugh
B. Jeffrey
M. Donovan

FEDERAL COORDINATION REGULATIONS
Sections 4 & 6
RECORD OF DETERMINATION

HIGHWAY 104 AT ANTIGONISH - NOVA SCOTIA

FEDERAL AUTHORITY: Fisheries & Oceans Canada Fisheries Act
NAME & TITLE: James Leadbetter Evaluation & Mitigation Officer
SIGNATURE: James Leadbetter DATE: 10 / 10 / 01
dd / mm / yy

Is your Department / Agency:

(a) **likely** to require an environmental assessment of the project ☑

(b) **not likely** to require an environmental assessment of the project ☐

(c) **in possession** of specialist or expert information or knowledge that is necessary to conduct the environmental assessment of the project ☑

Does your Department / Agency

(d) require additional information to make a determination under items (a), (b) or (c) ☐

If the answer to (a) is "yes"

- Indicate the "trigger" under section 5 of the *Canadian Environmental Assessment Act*

Trigger: 5(1)(d)

- Identify the contact person for the environmental assessment if different from above.

Name & Title: Same as above
Address: Fisheries and Oceans Canada, Habitat Management Division 8505 5th floor P.O. Box 1006 Dartmouth N.S. B2Y 4A2
Telephone/Fax: tel 902 426 6027 fax 904 426 1489
e-mail: leadbetterj@mar.dfo-mpo.gc.ca

If the answer to (d) is "yes", the Regulations require that the additional information be requested within 10 days after making the determination.

Please return by fax to:
CANADIAN ENVIRONMENTAL ASSESSMENT AGENCY
Fax Number: (902) 426-6550

APPENDIX G

WATER SUPPLY PROTECTION

- Well Water Survey Protocol
- Proposed Controls for the Lower South River Wellfield

WATER SUPPLY PROTECTION

This appendix contains information on domestic water supply for the study area including individual wells and areas supplied by Municipal Town or County services. A preliminary risk analysis indicating wells that could be affected by the Project and therefore will require monitoring is duplicated in this Appendix, from Section 5.2 of the main body of the report. Readers are encouraged to read Section 5.2 for additional information and context. Details on a domestic well monitoring plan are also provided in this Appendix, as well as controls for the Lower South River Wellfield and Recharge Area.

Domestic Water Supply

Table G1 summarizes the general density and frequency of wells within the proposed alignment along existing roads and highways, and indicates the areas supplied by Municipal Town or County services.

Table G.1 Estimated Number and Type of Domestic Wells within 500 m of the Proposed Highway 104 Alignment

Locations	Chainage	Dug Wells	Drilled Wells	Drilled Municipal Supply Well	Dug Surface Water Reservoirs	Assumed Wells (Unknown)	Water Supplied by Municipal Systems	Total Wells (Including Assumed Wells)
RoW from the Western End of the Alignment to Addington Forks Rd.	0+000 to 1+900							
Existing Highway 104	0+000 to 1+900	0	0	0	0	2	No	2
Trunk 4	1+900	10	5	0	0	5	No	20
Addington Forks Rd.	1+900	0	0	0	0	0	Yes	0
RoW from Addington Forks Rd. to West River	1+900 to 5+700							
Existing Highway 104	North of RoW	0	0	0	0	0	Yes	0
Sommers Rd.	North of RoW	0	0	0	0	0	Yes	0
Town of Antigonish	North of RoW	0	0	0	0	0	Yes	0
Trunk 7	4+200	0	0	0	0	0	Yes	0
Church Street Extension	5+400	3	0	0	0	1	Partial: Existing Highway 104 to Cunningham Rd.	4
Cunningham Rd.	5+550	2	0	0	0	2	No	4
RoW from West River to Beech Hill Rd.	5+700 to 6+700							
Existing Highway 104	North of RoW	0	0	0	0	0	Yes	0
Willowdale Lane	North of RoW	0	0	0	0	0	Yes	0
Beech Hill Rd.	6+700	1	1	0	0	1	Partial: North of Existing Highway 104	3
Beech Hill Rd. to Existing Highway 104	6+700 to 10+400							
Existing Highway 104	North of RoW	3	0	0	1	0	Yes: North Side Partial: South Side	4

Table G.1 Estimated Number and Type of Domestic Wells within 500 m of the Proposed Highway 104 Alignment

Locations	Chainage	Dug Wells	Drilled Wells	Drilled Municipal Supply Well	Dug Surface Water Reservoirs	Assumed Wells (Unknown)	Water Supplied by Municipal Systems	Total Wells (Including Assumed Wells)
Trunk 4	North of RoW	0	0	0	0	0	Yes	0
MacEachern Loop	North of RoW	1	0	0	0	1	No	2
Existing Highway 104 to the Eastern End of the Alignment	10+400 to 14+825.65							
Existing Highway 104	South of RoW	0	2	0	0	0	Yes	2
Dunn's Loop	10+550	0	0	0	0	3	No	3
South River Loop	South of RoW	2	0	0	0	1	Partial: East End	3
Dunmore Rd.	South of RoW	0	0	0	0	1	Partial: 100 m off Existing Highway 104	1
South Side Harbour Rd.	11+500	0	0	0	0	0	Yes	0
Route 316	South of RoW	2	1	0	0	0	Partial: 100 m Off Existing Highway 104	3
Lower South River Wellfield (Wells and Protected Area)	South of 12+200 to 14+827.65	0	0	6	0	0	County Wellfield	6
Lower South River Mobile Home Park	South of RoW	0	0	0	0	0	Yes	0
Angus MacQuarrie Drive	South of RoW	0	0	0	0	0	Yes	0
Taylor Rd.	13+950	2	8	0	0	2	No	12
Total Wells		**26**	**17**	**6**	**1**	**19**	**N/A**	**69**

Preliminary Risk Analysis

The following comments and assessment of potential risk of well damage from this alignment are based on a field reconnaissance survey on October 10 and 11, 2002, published water well information for each area, and the proposed cut and fill operations planned for the RoW.

Existing Highway 104 (North and South of 0+000 to 14+825.65)

The majority of the existing Highway 104 is serviced by either Municipal Town or County Water with the exception of seven properties with civic addresses on the highway that were either confirmed or suspected of having a drilled or dug well. These properties include: two with drilled wells (Smith & Fraser Homes and Softspray Car Wash (Civic Nos. unknown)); three with dug wells (Civic Nos. 3770, 4278 and one unknown civic number); and two unknown wells at the western end of the alignment (Civic Nos. 2416 and 2448).

The two drilled wells are not likely to be affected by the re-alignment. The dug well at 3770 Highway No. 104 is discussed in the Beech Hill Road (6+700) section, and the unknown wells at 2416 and 2448 Highway No. 104 are discussed in the Trunk 4 (North of 0+000 to 1+900) and Addington Forks Road (0+000 to 1+900) section.

The two dug wells at 4278 Highway No. 104 and Kent Mobile Homes are located north and downgradient of the 9+300 to 9+550 where a filling operation of up to 23 m will take place. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages. The closest dug well will be monitored during construction of the highway and underpass.

County of Antigonish municipal water lines exist in the approximate area of 10+400 where the proposed alignment meets the existing alignment of Highway 104. Construction in this area will plan for the presence of underground services in this area.

Trunk 4 (North of 0+000 to 1+900) and *Addington Forks Road (0+000 to 1+900)*

Eighteen residences or commercial properties on Trunk 4 west of Antigonish and immediately north of the proposed western connection to Highway 104 are served by both drilled wells (Civic Nos. 2376, 2388, 2456 and two unknown civic numbers) and dug wells (Civic Nos. 2354, 2547, 2573, 2647, 2667 and five unknown civic numbers). In addition, the presence of a well could not be confirmed but is suspected at four properties (Civic Nos. 2406, 2428 and two unknown civic numbers). The closest observed drilled and dug wells are approximately 100 m and 50 m north of the RoW, respectively. Two properties within 50 m on the south side of the RoW (Highway 104) could not be accessed during field reconnaissance, but would also have a drilled or dug well.

Seven domestic well logs for this area (Tables 5.9 and 5.10) indicate that dug wells have an average well depth of 6.6 m and a well yield of 568 L/min. Drilled wells had an average depth of 40.4 m, casing length of 28.1 m; well yield of 47.9 L/min (1.1 to 113.6. L/min), and overburden thickness averaging 38.5 m (range 23.0 to 65.6 m), which suggests deep glacial deposits in this vicinity.

The underpass does not involve a major cut (*i.e.*, is not greater than 6 m); therefore the dug wells which are within 50 m down gradient along Trunk 4 are not likely to be dewatered. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent downgradient dug wells to the north of the RoW. The closest dug well will be monitored during construction of the highway and underpass in this area.

Residences along Addington Forks Road within the study area are serviced by Antigonish County water. The proposed underpass must accommodate underground services in this area.

Table G.2 Summary of Dug Well Information - Proposed Highway 104 Alignment Antigonish

Location	Well Depth (m)	Casing (m)	Diameter (mm)	Est., Yield (L/min)	Water Level (m)	Overburden Thickness (m)
All Wells (Trunk 4)						
Minimum	4.9	4.9	914.4	567.8	3	4.9
Maximum	8.2	8.2	914.4	567.8	4.1	8.2
Mean	6.6	6.6	914.4	567.8	3.5	6.6
Median	6.6	6.6	914.4	567.8	3.5	6.6
Number	2	2	2	1	2	2

Table G.3 Summary of Drilled Well Information - Proposed Highway 104 Alignment Antigonish

Location	Well Depth (m)	Casing (m)	Diameter (mm)	Est., Yield (L/min)	Water Level (m)	Overburden Thickness (m)
All Wells						
Minimum	16.4	0	0	1.1	-0.3	0
Maximum	122.7	54.1	200	567.8	34.4	67.7
Mean	42.8	19.1	143.5	61.2	10.9	18.2
Median	40.4	19.7	152.4	37.9	9.8	16.4
Number	61	61	61	60	59	61

Table G.3 Summary of Drilled Well Information - Proposed Highway 104 Alignment Antigonish

Location	Well Depth (m)	Casing (m)	Diameter (mm)	Est., Yield (L/min)	Water Level (m)	Overburden Thickness (m)
Residential Drilled Wells in the Vicinity of 0+000 to 1+900						
Minimum	23	13.8	152.4	1.1	-0.3	23
Maximum	65.6	54.1	152.4	113.6	13.1	65.6
Mean	40.4	28.1	152.4	47.9	8.2	38.5
Median	34.4	23.3	152.4	30.3	9.2	25.3
Number	5	5	5	5	5	5
Residential Drilled Wells in the Vicinity of 1+900 to 5+700						
Minimum	16.4	0	101.6	11.4	0.3	0
Maximum	122.7	37.1	152.4	219.6	34.4	32.8
Mean	45.9	18.5	139.7	42.5	16.5	17.6
Median	41.8	22	152.4	28.4	13.5	19.7
Number	16	16	16	16	16	16
Residential Drilled Wells in the Vicinity of 5+700 to 10+400						
Minimum	23.3	6.6	101.6	7.6	4.9	0.7
Maximum	64	36.1	152.4	567.8	32.8	29.5
Mean	42.9	19.2	145.1	98.7	10.6	15.1
Median	41.8	20	152.4	37.9	7.5	18.9
Number	14	14	14	13	13	14

Table G.3 Summary of Drilled Well Information - Proposed Highway 104 Alignment Antigonish

Location	Well Depth (m)	Casing (m)	Diameter (mm)	Est., Yield (L/min)	Water Level (m)	Overburden Thickness (m)
Residential Drilled Wells in the Vicinity of 10+400 to 14+825.65						
Minimum	24.6	6.6	0	7.6	0	1.3
Maximum	72.2	30.8	152.4	151.4	19.7	45.9
Mean	37.8	17.8	136.7	43.2	8.5	13.4
Median	34.4	16.4	152.4	26.5	9.2	9.8
Number	21	21	21	21	21	21
County of Antigonish Water Supply Wells (South of 13+000)						
Minimum	41.8	12.2	152	50	-1	4.5
Maximum	67.7	27.4	200	200	10.5	67.7
Mean	55.9	16.9	171.2	113	4.1	29.2
Median	61	13.4	152	90	1.5	26.8
Number	5	5	5	5	5	5

Sources: NSDEL Well Drillers Logs 1969-2000 and C.J. MacLellan & Associates Inc. 2002.

Sommers Road (Northwest of 2+600)

Residences along Sommers Road within the study area are serviced by Antigonish County water. The proposed RoW passes south of Sommers Road.

Town of Antigonish (North of 3+800 to 5+900)

The residential and commercial buildings of the Town of Antigonish are supplied by municipal services. The proposed RoW passes south of the town and does not enter into the town limits.

Trunk 7 (4+200)

Residences along Trunk 7 within the study area are serviced by Antigonish County water. The proposed underpass will plan for underground services in this area.

Church Street Extension (5+400) and Cunningham Road (5+550)

Five residences or commercial properties situated along Church Street Extension and Cunningham Road are served by dug wells (185 Church Street Ext. and two unknown civic numbers, and 280 Cunningham Road and an unknown civic number). In addition, the presence of a well could not be confirmed but is suspected at three properties (155 Church Street Ext., 73 Cunningham Road and one unknown civic number on Cunningham Road). Wells in this area are

within 50 m of the RoW. The street is serviced by County water north of the junction of Church Street extension and Cunningham Road. Well logs were not available for this area.
Work at this crossing will involve placement of a service road and discontinuing a portion of Church Street Extension and Cunnington Road. The RoW will pass over top of two wells listed above (dug well at 280 Cunnington Road and the suspected well at the unknown civic number on Cunningham Road and commercial operation). There is also major fill planned for 5+630 to 5+870. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent dug wells.

Willowdale Lane (North of 5+950 to 6+100)

Residences along Willowdale Lane are serviced by Antigonish County water. The proposed RoW passes south of Willowdale Lane.

Beech Hill Road (6+700)

Beech Hill Road is serviced by County of Antigonish municipal services north of the existing Highway 104. South of the existing Highway 104 are three wells within the study area. One drilled well (County of Antigonish building), one dug well (Department of Natural Resources building) and one unknown well. The proposed highway overpass here will have to take into consideration potential for water quality impacts to these wells as well as the dug well at Civic No. 3770 along the current Highway 104.

The work here will involve the placement of up to 9.5 m of fill during the construction of the overpass. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent dug wells.

Trunk 4 (Northeast of 7+000 to 8+300)

Residences along Trunk 4 East of Antigonish are serviced by Antigonish County water. The proposed RoW passes south of Trunk 4 in this location.

MacEachern Loop (North of 9+650 to 10+100)

Two residences and one commercial property are situated along MacEachern Loop. The

MacEachern Collision Centre is served by a surface water reservoir. One dug well and one assumed well serve the two residences on MacEachern Loop. These wells are at least 150 m north and downgradient of the proposed RoW so the 11 m deep road cut in this area is not likely to de-water these wells. However, there is risk of temporary siltation of the dug well from vibration during the construction stage. The surface water reservoir is not currently considered potable, so minor degradation of this source is not a significant concern. Well logs were not available for this area.

Dunn's Loop (10+600)

The RoW passes over Dunn's Loop at 10+555. Three residential properties here have unconfirmed wells. Two of the houses owned by Dunn will be within 50 m of the proposed RoW. The third property contains a dilapidated home which may need to be removed during construction. Any well on this property is not currently in use.

The work at this location includes a major road cut up to 18.5 m. If the indicated wells are dug wells, there is risk of de-watering and temporary siltation from vibration during the construction stage. Drilled wells this close to the alignment would be at risk from blasting.

The potential wells in this location will be monitored during construction across Dunn's Loop.

South River Loop (South of 10+650), Dunmore Road (South of 11+350) and Route 316 (South of 12+150)

These roads include partial service by County of Antigonish municipal water, four dug wells (10 and 24 South River Loop, and 4667 and 4669 Route 316), one drilled well (4665 Route 316) and two assumed wells (12 South River Loop and 5285 Dunmore Road). The RoW does not cross these roads but the noted wells are within the study area.

The dug wells along South River Loop are within 50 m upgradient of the RoW, so the proposed 18.5 m deep road cut across Dunn's Loop could result in dewatering of these wells. In addition, there is risk of temporary siltation of the dug wells along South River Loop from vibration during the construction stage. The closest of these wells will be monitored during construction of the highway. The closest wells along Dunmore Road and Route 316 are 200 m and 500 m upgradient of the RoW, respectively, are not expected to be affected by construction of the RoW.

South Side Harbour Road (11+500)

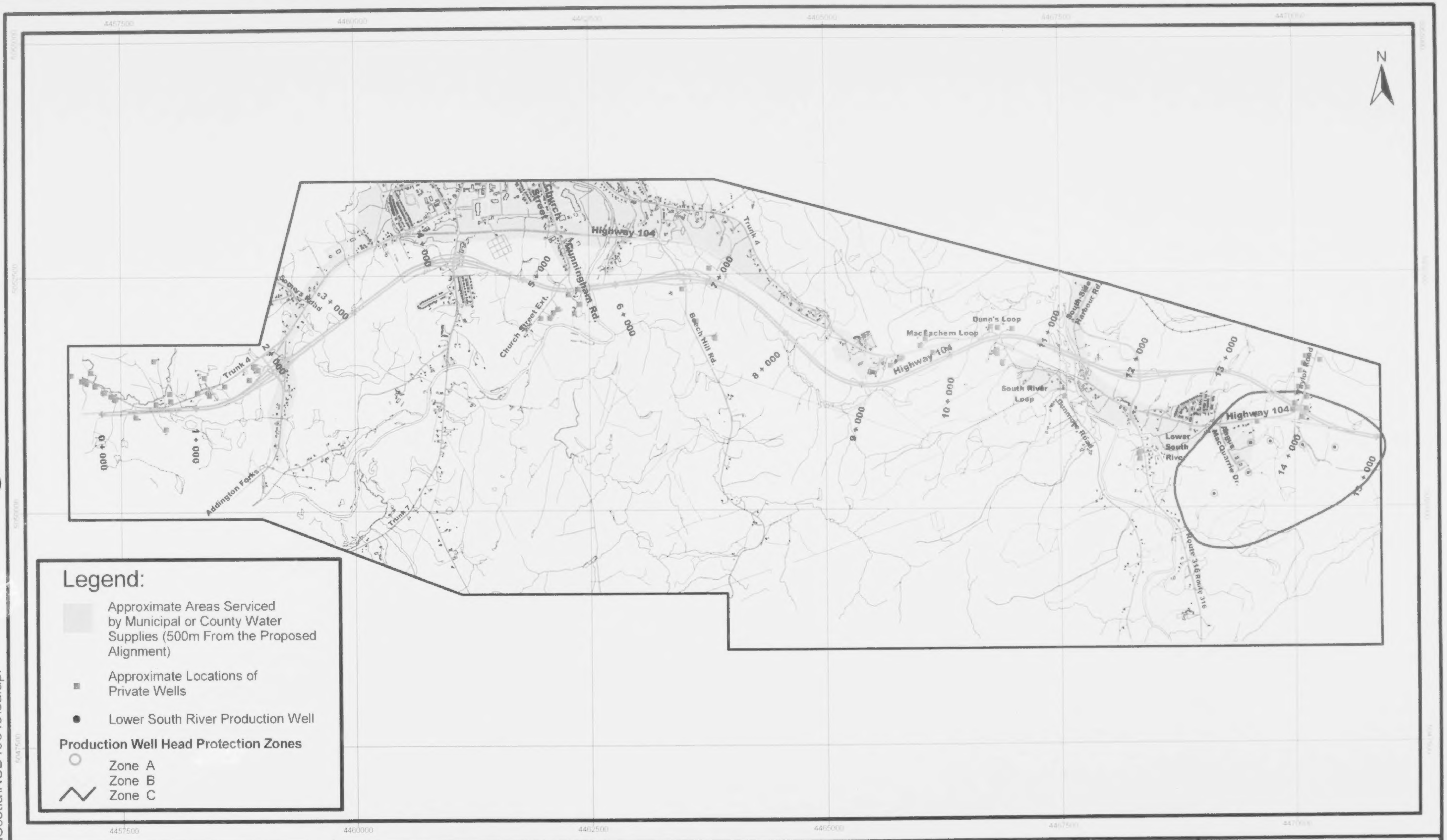
Residences along South Side Harbour Road within the study area are serviced by Antigonish County water. A portion of this road will be discontinued, and relocated, and a highway underpass will be constructed at 12+150.

Lower South River Wellfield Protected Area (South of 12+200 to 14+827.65)

The Lower South River water supply wellfield consists of six production wells. However, information was only available on five of these wells during the preparation of this report. The supply wells have an average depth of 55.9 m, an average casing length of 16.9 m, an average well yield of 113 L/min (50 to 200 L/min), and overburden thickness averaging 29.2 m (range from 4.5 to 67.7 m), which suggests deep glacial deposits in this vicinity. The closest of these wells is within 100 m and upgradient of the RoW which passes through the Zone C protection zone for the wellfield. The location of the wells and protection zone are shown on Figure G.1

The Lower South River Wellfield has a well head protection area made up of three protection zones, each with a different level of protection progressively more stringent as the zones move in closer to the wells. The zones were established to roughly correspond with groundwater travel times of three months for Zone A, the closest protection zone, one year for Zone B and twenty-five years for Zone C, the protection zone with the furthest extent (C.J. MacLellan & Associates Inc. 2002). The recommended activity restrictions, or proposed control measures, for each of these zones are shown in Table G.4. Restrictions are focussed on limiting the storage and use of petroleum fuels and solvents, chlorinated solvents, pesticides, fertilizers to varying degrees within the protection zones. Activities such as sewerage disposal, groundwater production, groundwater heat pumps, forestry development and mining and aggregate removal are also prohibited or limited within these zones.

The proposed RoW passes through Zone C. Because the construction period for the highway in this location is anticipated to be less than one year, impacts to the wellfield are not anticipated from construction activities. Development of associated off-RoW works (*i.e.*, pits and quarries, refuelling areas, disposal areas) will have to consider the proposed wellfield control measures (C.J. MacLellan & Associates Inc. 2002) in this area during construction. Post construction controls for road salting and salt storage in this area will need to be in accordance with the proposed control measures for the wellfield outlined in Table G.1.



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Jacques Whitford

NOVA SCOTIA
Transportation and Public Works

SCALE: 1 : 37 500	
Date: 12/17/2004	
Drawn By: GM	
Approved By:	

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

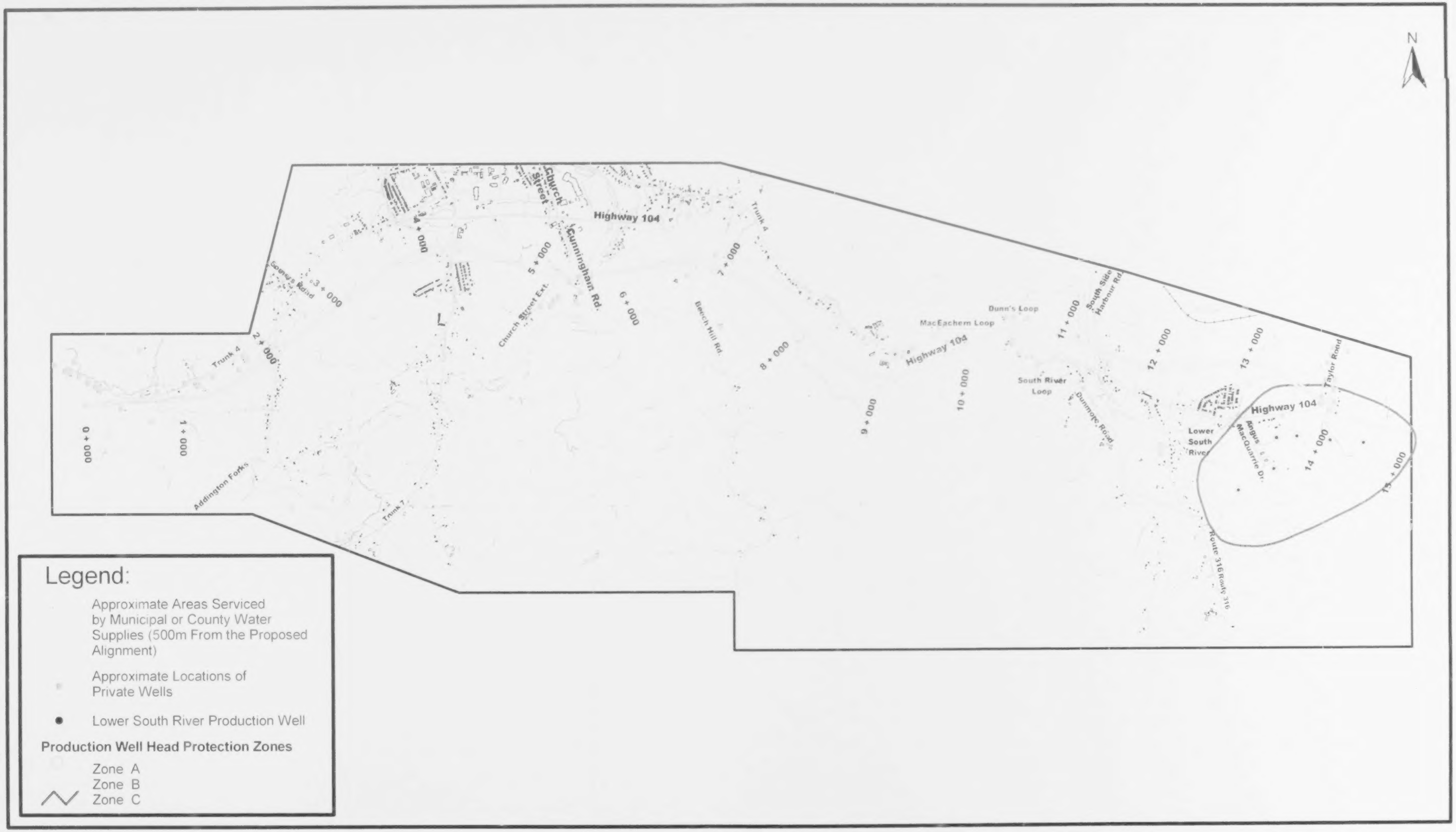
ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Municipal Wellfield and Water Supply Areas

.5 0 .5 1.0 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.
NSD16949
FIGURE G.1



Jacques Whitford

NOVA SCOTIA
Transportation and Public Works

SCALE: 1 : 37 500
Date: 12/17/2004
Drawn By: GM
Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Municipal Wellfield and Water Supply Areas

.5 0 .5 1.0 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.

NSD16949
FIGURE G.1

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Table G4 Proposed Controls for Lower South River Wellfield and Recharge Area

Activities & Materials	Criteria	Zone A Wellhead Protection Zone *1 day to 3 months Delay Time*	Zone B Wellfield Protection Zone *3 Months to 1 Year Delay Time*	Recharge Area Zone C *1 to 25 Years Delay Time*
Petroleum Fuels (gasoline, diesel, fuel oil, jet fuel, lubricating oils)	Storage Use Bulk Transport	: not permitted : not permitted : not permitted	: permitted in containers up to 1,000 litres capacity : permitted in compliance with NS EFM Plan : permitted with controls	: permitted in containers up to 40,000 litres capacity : permitted in compliance with NS EFM Plan : permitted
Petroleum Solvents (paint thinners, degreasers, etc.)	Storage Use Bulk Transport	: not permitted : not permitted : not permitted	: permitted in containers up to 50 litres capacity : permitted in compliance with NS EFM Plan : not permitted	: permitted in containers up to 1,000 litres capacity : permitted in compliance with NS EFM Plan : permitted
Chlorinated Organic Compounds (dry cleaning chemicals, PCBs, etc.)	Storage Use Bulk Transport	: not permitted : not permitted : not permitted	: permitted in containers up to 50 litres capacity : permitted in compliance with NS EFM Plan : not permitted	: permitted in containers up to 1,000 litres capacity : permitted in compliance with NS EFM Plan : permitted
Pesticides & Herbicides	Storage Use Bulk Transport	: not permitted : not permitted : not permitted	: permitted in containers up to 50 litres capacity : permitted in compliance with NS EFM Plan : not permitted	: permitted in containers up to 1,000 litres capacity : permitted in compliance with NS EFM Plan : permitted
Fertilizers (synthetic and manure)	Storage Use Bulk Transport	: not permitted : not permitted : not permitted	: permitted in containers up to 1 tonne capacity : permitted in compliance with NS EFM Plan and NS Nutrient Management Plan : permitted with controls	: permitted in containment systems : permitted in compliance with NS EFM Plan and NS Nutrient Management Plan : permitted with controls
Salt (de-icing agents)	Storage Use Bulk Transport	: not permitted : not permitted : not permitted	: permitted in containers up to 1 tonne capacity : limited use permitted (salt-sand mixture) : permitted with controls	: permitted with containment up to 100 tonnes capacity : permitted : permitted
Sewerage Disposal Systems (septic systems)	Activity	: not permitted	: not permitted	: small systems permitted
Groundwater Production well pumping, artesian flow)	Activity	: not permitted other than LSR Wells : abandoned wells should be plugged	: new wells not permitted other than Village Wells : abandoned wells should be plugged	: only house wells permitted : abandoned wells should be plugged
Groundwater Heat Pumps	Activity	: not permitted	: not permitted	: small residential and commercial systems permitted
Forestry Development	Activity	: not permitted	: not permitted	: not permitted
Mining & Quarries	Activity	: not permitted	: not permitted	: small operations permitted

Note: NSEFM Plan - Nova Scotia Environment Farm Management Plan
LSR - Lower South River

Adapted From: (C.J. MacLellan & Associates Inc. 2002)

Blasting in the area of Taylor Road could damage these wells so ripping techniques will be utilized for bedrock removal (if necessary). Since these wells supply a vast area of the county, they will be monitored during construction of the Route 316 connector between 13+500 to 14+827.65.

Lower South River Mobile Home Park (South of 12+500 to 12+950)

The mobile home park in Lower South River is serviced by Antigonish County municipal water. The proposed RoW passes north of the Mobile Home Park.

Angus MacQuarrie Drive (South of 13+000)

Angus MacQuarrie Drive is serviced by the County of Antigonish municipal water and the RoW passes north of this road.

Taylor Road (13+950)

Nine residences or commercial properties on Taylor Road are served by both drilled (Civic Nos. 8, 21, 47, 65 and three unknown civic numbers (owners: Benoit, Landry and one unknown)) and dug wells (Civic Nos. 59 and unknown (owner: MacPherson)). In addition, the presence of a well could not be confirmed but is suspected at two properties (Civic Nos. 112 and 139). The RoW passes over three of these properties (Civic Nos. 8, 21 and 47) and both drilled and dug wells will be within 50 m of the RoW.

Nine domestic well logs for this area indicate that drilled wells had an average depth of 34.3 m, casing length of 18.7 m; well yield of 4.4 L/min (1.2 to 12.1. L/min), and overburden thickness averaging 16.5 m (range from 1.2 to 42.7 m), which varied depths of glacial deposits in this vicinity.

A major cut is not planned for the underpass at Taylor Road. However, one of the wells on Taylor Road encountered less than 2 m of overburden. Therefore even a minor cut in this area may encounter bedrock. It should be noted that blasting here could damage drilled wells on Taylor Road close to the RoW. The highway underpass at Taylor Road is also within 100 m of Antigonish County's nearest water supply wells. Work in this area will involve ripping techniques if bedrock removal is necessary. A moderate road cut in this area could de-water dug wells. There is risk of temporary siltation of drilled and dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent dug wells. The nearest dug wells will be monitored during construction.

Any dug wells located within 50 m of a major highway cut, underpass or overpass will therefore be inspected by the contractor, measured for water level and depth, and inventoried for possible future reference. Dug wells within 50 m are noted along Trunk 4, Church Street Extension, Cunningham Road, Beach Hill Road, Dunns Loop and Taylor Road.

Summary of Monitoring and Follow-up Requirements

Several wells are located within the 500 m assessment boundary, particularly where the alignment crosses existing roads. NSTPW's Construction Contractor will complete an inventory of residential water wells. This would include an interview of the well owner, documentation of well construction specifics, collection of a water sample for chemical and bacteria analysis, and photographic documentation of the well location. A contingency plan will also be developed for the area of the wellfield protection zones to ensure that any potential malfunctions or accidental events are addressed appropriately and in a timely manner to minimize potential impacts to the wellfield that could arise from highway operations.

In the event that any residential wells are found within 500 m of any blasting excavation areas (road cut or quarry), or if dug wells are located within 50 m of a major (> 5 m) overburden cut, these wells will be inspected (measuring depth, yield and water level in dug wells), and sampled for baseline water quality (Rcap-MS and bacteria). Where several drilled wells are present within the proposed 500 m blast monitoring radius, selected representative proximal wells will be inspected, baseline sampled, and closely monitored during the construction phase. The Contractor will implement a contingency plan to provide temporary water during construction, and to repair or replace any wells found to be permanently damaged, in the event that wells are adversely or permanently affected by the Project.

Because water levels may change slowly over time in tight glacial till aquifers, follow-up water level monitoring is proposed for shallow dug wells located close to major overburden cuts along the alignment. Natural seasonal variation in water levels will be considered in the evaluation of effects. The suggested duration of any post-construction monitoring would be the lesser of two years of quarterly monitoring, or stabilization of water level or chemical indicators in wells of concern.

Domestic Well Monitoring Plan

Pre-construction Monitoring

Pre-construction monitoring will be conducted to collect baseline groundwater data for wells potentially affected by deep overburden excavation (dewatering) and blasting.

- After the final alignment has been determined, a more detailed determination of the closest domestic water well locations with respect to the alignment will be made.

- All wells located within 500 m of any blasting will be field truthed and located on appropriate mapping relative to the alignment. The closest wells at each blast site will be inventoried, yield tested and sampled for baseline water quality (*i.e.*, Rcap-MS+bacteria). Low yield wells (< 0.5 igpm) identified within the survey zone will also be inspected, if possible. All inspections and testing will be conducted by a NSDEL certified pump installer.

Post-Construction Monitoring

- Because water levels may change slowly over time in tight glacial till aquifers, follow-up water level monitoring is recommended for shallow dug wells located close to major overburden cuts along the alignment. Natural seasonal variation in water levels will be considered in the evaluation of effects.

- The suggested duration of any post-construction monitoring would be the lesser of 2 years of quarterly monitoring, or stabilization of water level or chemical indicators in wells of concern.

Procedure for Field Truthing and Residential Well Inventory

Field truthing involves a door-to-door survey of residential water well supplies in proximity to a major development. The survey boundary is dependent on the nature and potential severity of the hazards to wells.

A standard procedure involving a questionnaire is generally used (see attached questionnaire). Each property owner within 100 m (dug wells at risk from dewatering) to 500 m (all wells at risk from blasting) would be contacted and interviewed respecting their well water supply. Specific information will be collected on: type of well (dug, drilled, spring), well depth, diameter, casing length; water levels, well yield or historical yield problems, well location and well completion methods, and septic field location. Information from the questionnaires will be matched with well drillers logs from the NSDEL Well Driller's Logs databases (1965 to 1978 in books; 1978 to present in database form). Photographs are typically taken of visible well completions, and field comments are made regarding well location and potential for impact from the alignment construction or other constraints such as septic fields, roads, fuel tanks or waste deposits.

A representative unfiltered and unpreserved water sample is collected from the point of use and prior to any water quality treatment systems, for analysis of general chemistry, metals and for total and fecal coliform bacteria. For larger projects, only the closer wells are subjected to chemical analysis; the remaining samples being archived. Results of the water quality analysis are copied to the well owners. Analytical results are retained for up to two years for possible future use in the arbitration of well damage claims.

Dug wells deemed to be at risk to aquifer dewatering by large road cuts are measured for both depth and water levels, and a short yield test is performed by a certified pump installer using the existing pumping system.

Drilled wells at risk to possible damage from major blasting operations are also inspected for depth, water level, and a short yield test is performed by a certified pump installer. Typically this would be done only for the closest few wells deemed to be most at risk, since cost and possible inconvenience to the well owner is involved in the excavation and plumbing modifications.

WATER WELL QUESTIONNAIRE

1.0 OWNER/RESIDENT INFORMATION

Owner/Resident Name:		**PID Number:**
Address:		**Res. Since?:**
Municipality:	**Province:**	**Postal Code:**
Phone:	**Prev. Owner:**	
Number of Occupants:	**Estimated Daily Usage:**	**Principal Water Usage:**

2.0 WELL INFORMATION

Anecdotal ☐ **Well Log** ☐

Well Type: *Dug* ☐ *Drilled* ☐ *Drivepoint* ☐ *Spring (artesian)* ☐ *Cistern* ☐ *Other:*

Drilled By:	**Well Log Available?** *Yes* ☐ *No* ☐	
Original Owner:	**Aquifer Type:**	
Date Drilled:	**Well Diameter:**	**Well Screen?:** *Yes* ☐ *No* ☐
Well Depth:	**Casing Diameter:**	**Casing Seal?:** *Yes* ☐ *No* ☐
Casing Length:	**Well Stickup:**	**Pump Setting:**
Water Depth:	**Date:**	**Northing:**
Well Location:	**Est. Yield:**	**Easting:**
Well Accessible?: *Yes* ☐ *No* ☐	**Photographed?:** *Yes* ☐ *No* ☐	**Estimated Yield:**
Pump Type: *Submersible* ☐ *Jet* ☐ *Other:*	**Past Pumping Test Performed:** *Yes* ☐ *No* ☐	

3.0 WATER QUALITY

Are records of Water Quality Available?

When was well last sampled? **Sampled By?**

What parameters were tested? *General Chemistry* ☐ *Metals* ☐ *Bacteria* ☐ *Other:*

What is general Water Quality?: *Taste* ☐ *Odour* ☐ *Staining* ☐ *Mineralization* ☐ Silt/Sediment ☐ *Other:*

Water Treated?: **Treatment Type?:** *Softener* ☐ *Carbon* ☐ *Other:*

Are there any other wells on your property? Reason why replaced?:

Can a sample be obtained before Treatment/Taps?:

Can a sample or water level measurement be obtained directly from the well?:

What is the normal water level in your well?:

What is the normally observed range of fluctuation? **Seasonally?** **High Usage?:**

Has the well ever gone dry?:

Are there groundwater problems in the area?:

Are there water supply springs near by?:

Type of septic disposal system:

Location of septic disposal system:

Depth of septic disposal system:

4.0 WATER SAMPLE

Sample ID: **Sample Taken From:**

Comments:

Sketch on Back

Interview By: *Date:*

APPENDIX H

TERRESTRIAL FIELD SURVEY RESULTS

- Mammal Species Recorded in the Study Area
- Bird Species Recorded in the Breeding Bird Atlas
- Bird Species Recorded During the Breeding Bird Survey
- Bird Abundance by Habitat Type
- Vascular Plant Species Found in the Study Area

Table H1 Mammal Species Recorded in the Study Area and Expected to be Present in the Study Area

Common Name	Scientific Name
*Smoky Shrew	*Sorex fumeus*
*Cinerous Shrew	*Sorex cinereus*
Short-tailed Shrew	*Blarina brevicauda*
Star-nosed Mole	*Condylura cristata*
*Little Brown Bat	*Myotis lucifugus*
Snowshoe Hare	*Lepus americanus*
Eastern Chipmunk	*Tamias striatus*
American Red Squirrel	*Tamiasciurus hudsonicus*
*Northern Flying Squirrel	*Glaucomys sabrinus*
Beaver	*Castor canadensis*
Deer Mouse	*Peromyscus maniculatus*
Red-backed Vole	*Clethrionomys gapperi*
Meadow Vole	*Microtus pensylvanicus*
*Meadow Jumping Mouse	*Zapus hudsonius*
*Woodland Jumping Mouse	*Napaeozapus insignis*
Muskrat	*Ondatra zibethica*
Porcupine	*Erithizon dorsatum*
American Black Bear	*Ursus americana*
Coyote	*Canis latrans*
*Red Fox	*Vulpes vulpes*
Racoon	*Procyon lotor*
*Ermine	*Mustela erminea*
*American Mink	*Mustela vison*
Striped Skunk	*Mephitis mephitis*
*River Otter	*Lutra canadensis*
*Bobcat	*Lynx rufus*
White-tailed Deer	*Odocoileus virginianus*

* = Species not observed during field survey but expected to be present in the study area

Table H2 Bird Species Recorded in the Breeding Bird Atlas Squares in which the Study Area is Located

Common Name	Scientific Name	Breeding Status
Common Loon	*Gavia immer*	Confirmed
Pied-billed Grebe	*Podilymbus podiceps*	Confirmed
American Bittern	*Botaurus lentiginosus*	Confirmed
Great Blue Heron	*Ardea herodias*	Possible
Canada Goose	*Branta canadensis*	Possible
American Black Duck	*Anas rubripes*	Confirmed
Mallard	*Anas platyrhynchos*	Confirmed
Green-winged Teal	*Anas crecca*	Confirmed
Blue-winged Teal	*Anas discors*	Confirmed
Northern Pintail	*Anas acuta*	Possible
Northern Shoveler	*Anas clypeata*	Possible
American Wigeon	*Anas americana*	Confirmed
Wood Duck	*Aix sponsa*	Confirmed
Ring-necked Duck	*Aythya collaris*	Possible
Hooded Merganser	*Lophodytes cucullatus*	Confirmed
Common Merganser	*Mergus merganser*	Confirmed
Red-breasted Merganser	*Mergus serrator*	Confirmed
Osprey	*Pandion haliaetus*	Confirmed
Bald Eagle	*Haliaeetus leucocephalus*	Confirmed
Northern Harrier	*Circus cyaneus*	Confirmed
Sharp-shinned Hawk	*Accipiter striatus*	Probable
Northern Goshawk	*Accipiter gentilis*	Probable
Broad-winged Hawk	*Buteo platypterus*	Possible
Red-tailed Hawk	*Buteo jamaicensis*	Confirmed
American Kestrel	*Falco sparverius*	Confirmed
Merlin	*Falco columbarius*	Confirmed
Ring-necked Pheasant	*Phasianus colchicus*	Confirmed
Spruce Grouse	*Dendrogapus canadensis*	Confirmed
Ruffed Grouse	*Bonasa umbellus*	Confirmed
Virginia Rail	*Rallus limicola*	Possible
Sora	*Porzana carolina*	Probable

Table H2 Bird Species Recorded in the Breeding Bird Atlas Squares in which the Study Area is Located

Common Name	Scientific Name	Breeding Status
Piping Plover	*Charadrius melodus*	Confirmed
Killdeer	*Charadrius vociferus*	Confirmed
Willet	*Catoptrophorus semipalmatus*	Confirmed
Spotted sandpiper	*Actitis macularia*	Confirmed
Common Snipe	*Gallinago gallinago*	Confirmed
American Woodcock	*Scolopax minor*	Probable
Herring Gull	*Larus argentatus*	Confirmed
Great Black-backed Gull	*Larus marinus*	Confirmed
Common Tern	*Sterna hirundo*	Confirmed
Arctic Tern	*Sterna paradisaea*	Confirmed
Rock Dove	*Columba livia*	Confirmed
Mourning Dove	*Zenaida macroura*	Confirmed
Black-billed Cuckoo	*Coccyzus erythropthalmus*	Possible
Barred Owl	*Strix varia*	Probable
Great Horned Owl	*Bubo virginianus*	Probable
Northern Saw-whet Owl	*Aegolius acadicus*	Probable
Common Nighthawk	*Chodeiles minor*	Probable
Whip-poor-will	*Caprimulgus vociferus*	Probable
Chimney Swift	*Chaetura pelagica*	Confirmed
Ruby-throated Hummingbird	*Archilochus colubris*	Confirmed
Belted Kingfisher	*Ceryle alcyon*	Confirmed
Northern Flicker	*Colaptes aureus*	Confirmed
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Probable
Hairy Woodpecker	*Picoides villosus*	Confirmed
Downy Woodpecker	*Picoides pubescens*	Confirmed
Three-toed Woodpecker	*Picoides tridactylus*	Possible
Black-backed Woodpecker	*Picoides arcticus*	Probable
Pileated Woodpecker	*Dryocopus pileatus*	Confirmed
Alder Flycatcher	*Empidonax alnorum*	Probable
Eastern Wood Pewee	*Contopus borealis*	Possible
Tree Swallow	*Tachycineta bicolor*	Confirmed

Table H2 Bird Species Recorded in the Breeding Bird Atlas Squares in which the Study Area is Located

Common Name	Scientific Name	Breeding Status
Bank Swallow	*Riparia riparia*	Possible
Barn Swallow	*Hirundo rustica*	Confirmed
Cliff Swallow	*Hirundo pyrrhonota*	Confirmed
Gray Jay	*Perisoreus canadensis*	Confirmed
Blue Jay	*Cyanocitta cristata*	Confirmed
Common Raven	*Corvus corax*	Confirmed
American Crow	*Corvus brachyrhynchos*	Confirmed
Black-capped Chickadee	*Parus atricapillus*	Confirmed
Boreal Chickadee	*Parus hudsonicus*	Probable
Red-breasted Nuthatch	*Sitta canadensis*	Confirmed
Winter Wren	*Troglodytes troglodytes*	Probable
Gray Catbird	*Dumetella carolinensis*	Probable
American Robin	*Turdus migratorius*	Confirmed
Hermit Thrush	*Catharus guttatus*	Confirmed
Swainson's Thrush	*Catharus ustulatus*	Possible
Veery	*Catharus fuscescens*	Possible
Golden-crowned Kinglet	*Regulus satrapa*	Probable
Ruby-crowned Kinglet	*Regulus calendula*	Confirmed
Cedar Waxwing	*Bombycilla cedrorum*	Confirmed
European Starling	*Sturnus vulgaris*	Confirmed
Blue-headed Vireo	*Vireo solitarius*	Confirmed
Red-eyed Vireo	*Vireo olivaceus*	Confirmed
Black-and-white Warbler	*Mniotilta varia*	Confirmed
Tennessee Warbler	*Vermivora peregrina*	Confirmed
Nashville Warbler	*Vermivora ruficapilla*	Confirmed
Parula Warbler	*Parula americana*	Confirmed
Yellow Warbler	*Dendroica petechia*	Confirmed
Magnolia Warbler	*Dendroica magnolia*	Confirmed
Black-throated Blue Warbler	*Dendroica caerulescens*	Confirmed
Yellow-rumped Warbler	*Dendroica coronata*	Confirmed
Black-throated Green Warbler	*Dendroica virens*	Confirmed

Table H2 **Bird Species Recorded in the Breeding Bird Atlas Squares in which the Study Area is Located**

Common Name	Scientific Name	Breeding Status
Blackburnian Warbler	*Dendroica fusca*	Possible
Chestnut-sided Warbler	*Dendroica pensylvanica*	Confirmed
Bay-breasted Warbler	*Dendroica castanea*	Confirmed
Palm Warbler	*Dendroica palmarum*	Confirmed
Ovenbird	*Seiurus aurocapillus*	Confirmed
Northern Waterthrush	*Seiurus noveboracensis*	Possible
Common Yellowthroat	*Geothlypis trichas*	Confirmed
Canada Warbler	*Wilsonia canadensis*	Confirmed
American Redstart	*Setophaga ruticilla*	Confirmed
House Sparrow	*Passer domesticus*	Confirmed
Red-winged Blackbird	*Agelaius phoeniceus*	Confirmed
Northern Oriole	*Icterus galbula*	Possible
Rusty Blackbird	*Euphagus carolinus*	Possible
Common Grackle	*Quiscalus quiscula*	Confirmed
Brown-headed Cowbird	*Molothrus ater*	Possible
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Possible
Evening Grosbeak	*Coccothraustes vespertina*	Probable
Purple Finch	*Carpodacus purpureus*	Possible
Pine Siskin	*Carduelis pinus*	Probable
American Goldfinch	*Carduelis tristis*	Probable
White-winged Crossbill	*Loxia leucoptera*	Possible
Savannah Sparrow	*Passerculus sandwichensis*	Confirmed
Dark-eyed Junco	*Junco hyemalis*	Confirmed
Chipping Sparrow	*Spizella passerina*	Confirmed
White-throated Sparrow	*Zonotrichia albicollis*	Confirmed
Swamp Sparrow	*Melospiza georgiana*	Probable
Song Sparrow	*Melospiza melodia*	Confirmed

Table H3 Bird Species Recorded during the Breeding Bird Survey and their Breeding Status

Common Name	Binomial	Evidence of Breeding Activity
Great Blue Heron	*Ardea herodias*	None
American Black Duck	*Anas rubripes*	None
American Wigeon	*Anas americana*	Probable
Common Merganser	*Mergus merganser*	None
Osprey	*Pandion haliaetus*	Confirmed
Bald Eagle	*Haliaeetus leucocephalus*	None
Red-tailed Hawk	*Buteo jamaicensis*	Possible
Merlin	*Falco columbarius*	Probable
Ruffed Grouse	*Bonasa umbellus*	Confirmed
Killdeer	*Charadrius vociferus*	Possible
Common Snipe	*Gallinago gallinago*	Possible
American Woodcock	*Scolopax minor*	None
Ring-billed Gull	*Larus delawarensis*	None
Rock Dove	*Columba livia*	Probable
Mourning Dove	*Zenaida macroura*	Probable
Black-billed Cuckoo	*Coccyzus erythropthalmus*	Possible
Barred Owl	*Strix varia*	None
Ruby-throated Hummingbird	*Archilochus colubris*	None
Belted Kingfisher	*Ceryle alcyon*	None
Downy Woodpecker	*Picoides pubescens*	None
Hairy Woodpecker	*Picoides villosus*	None
Black-backed Woodpecker	*Picoides arcticus*	None
Northern Flicker	*Colaptes auratus*	Probable
Pileated Woodpecker	*Dryocopus pileatus*	None
Olive-sided Flycatcher	*Contopus borealis*	Possible
Yellow-bellied Flycatcher	*Empidonax flaviventris*	Possible
Alder Flycatcher	*Empidonax alnorum*	Possible
Tree Swallow	*Tachycineta bicolor*	None
Bank Swallow	*Riparia riparia*	None
Barn Swallow	*Hirundo rustica*	None
Blue Jay	*Cyanocitta cristata*	None

Table H3 Bird Species Recorded during the Breeding Bird Survey and their Breeding Status

Common Name	Binomial	Evidence of Breeding Activity
American Crow	*Corvus brachyrhyncos*	Confirmed
Common Raven	*Corvus corax*	None
Black-capped Chickadee	*Parus atricapillus*	Probable
Boreal Chickadee	*Parus hudsonicus*	Confirmed
Brown Creeper	*Certhia americana*	Possible
Golden-crowned Kinglet	*Regulus satrapa*	Possible
Ruby-crowned Kinglet	*Regulus calendula*	Possible
Veery	*Catharus fuscescens*	Possible
Swainson's Thrush	*Catharus ustulatus*	Possible
Hermit Thrush	*Catharus guttatus*	Probable
American Robin	*Turdus migratorius*	Confirmed
Cedar Waxwing	*Bombycilla cedrorum*	Probable
European Starling	*Sturnus vulgaris*	Confirmed
Blue-headed Vireo	*Vireo solitarius*	Probable
Red-eyed Vireo	*Vireo olivaceus*	Probable
Tennessee Warbler	*Vermivora peregrina*	Possible
Nashville Warbler	*Vermivora ruficapilla*	Possible
Northern Parula Warbler	*Parula americana*	Possible
Yellow Warbler	*Dendroica petechia*	Confirmed
Chestnut-sided Warbler	*Dendroica pensylvanica*	Possible
Magnolia Warbler	*Dendroica magnolia*	Possible
Yellow-rumped Warbler	*Dendroica coronata*	Probable
Black-throated Green Warbler	*Dendroica virens*	Possible
Blackburnian Warbler	*Dendroica fusca*	Possible
Palm Warbler	*Dendroica palmarum*	Confirmed
Black-and-white Warbler	*Mniotilta varia*	Possible
American Redstart	*Setophaga ruticilla*	Possible
Ovenbird	*Seiurus aurocapillus*	Probable
Northern Waterthrush	*Seiurus noveboracensis*	Possible
Common Yellowthroat	*Geothlypis trichas*	Probable
Canada Warbler	*Wilsonia canadensis*	None

Table H3 Bird Species Recorded during the Breeding Bird Survey and their Breeding Status

Common Name	Binomial	Evidence of Breeding Activity
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Possible
Chipping Sparrow	*Spizella passerina*	Probable
Savannah Sparrow	*Passerculus sandwichensis*	Possible
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*	Possible
Song Sparrow	*Melospiza melodia*	Confirmed
Lincoln's Sparrow	*Melospiza lincolnii*	Probable
Swamp Sparrow	*Melospiza georgiana*	Probable
White-throated Sparrow	*Zonotrichia albicollis*	Confirmed
Dark-eyed Junco	*Junco hyemalis*	Possible
Bobolink	*Dolichonyx oryzivorus*	Possible
Red-winged Blackbird	*Agelaius phoeniceus*	Confirmed
Common Grackle	*Quiscalus quiscula*	Confirmed
Brown-headed Cowbird	*Molothrus ater*	Possible
Purple Finch	*Carpodacus purpureus*	Possible
American Goldfinch	*Carduelis tristis*	Possible
Evening Grosbeak	*Coccothraustes vespertinus*	None
House Sparrow	*Passer domesticus*	Confirmed

Table H4 Bird Abundance by Habitat Type

Species	Number of Birds Observed or Heard during Breeding Bird Survey																							
	Habitats																							
	Mature Softwood	Immature Softwood	Mature Mixedwood	Immature Mixedwood	Mature Hardwood	Immature Hardwood	Clear Cut	Tallshrub Thicket	Lowshrub Thicket	Disturbed Area	Residential Area	Abandoned Pasture	Pasture	Agricultural Land	Tallshrub Swamp	Lowshrub Swamp	Coniferous Treed Swamp	Mixedwood Treed Swamp	Fresh Marsh	Brackish Marsh	Open Water	Habitat Unknown	Flew Over	
	MS	IS	MM	IM	MH	IH	CC	TT	LT	DA	RA	AP	PA	AL	TS	LS	CTS	MTS	FM	BM	OW	HU	FO	Total
Great Blue Heron																					3		3	6
American Black Duck																							1	1
American Wigeon																					3			3
Common Merganser																					2			2
Osprey																							1	1
Bald Eagle			1																				1	2
Red-tailed Hawk														1										1
Merlin			1																					1
Ruffed Grouse		1													5			1						7
Killdeer														1										1
Common Snipe										1					1									2
American Woodcock										1					1									2
Ring-billed Gull														15										15
Rock Dove											5												1	6
Mourning Dove						2					3				4							1	5	15
Black-billed Cuckoo								2																2
Barred Owl	1																							1

Table H4 Bird Abundance by Habitat Type

Species	Number of Birds Observed or Heard during Breeding Bird Survey																						
	Habitats																						
	Mature Softwood	Immature Softwood	Mature Mixedwood	Immature Mixedwood	Mature Hardwood	Immature Hardwood	Clear Cut	Tallshrub Thicket	Lowshrub Thicket	Disturbed Area	Residential Area	Abandoned Pasture	Pasture	Agricultural Land	Tallshrub Swamp	Lowshrub Swamp	Coniferous Treed Swamp	Mixedwood Treed Swamp	Fresh Marsh	Brackish Marsh	Open Water	Habitat Unknown	Flew Over	
	MS	IS	MM	IM	MH	IH	CC	TT	LT	DA	RA	AP	PA	AL	TS	LS	CTS	MTS	FM	BM	OW	HU	FO	Total
Ruby-throated Hummingbird								2							1									3
Belted Kingfisher					1										1								1	3
Downy Woodpecker					1										1									2
Hairy Woodpecker															1									1
Black-backed Woodpecker	1																							1
Northern Flicker			2	2		3	1							1	2									11
Pileated Woodpecker																		1						1
Olive-sided Flycatcher	2		1												1									4
Yellow-bellied Flycatcher																						1		1
Alder Flycatcher		1		11		17		9	1						2									41
Tree Swallow																							3	3
Bank Swallow																							1	1
Barn Swallow																							1	1
Blue Jay	1		1	1	1			4										2				2	1	13
American Crow	4					3		4			3			5									8	27
Common Raven																							10	10
Black-capped Chickadee				2		12		4							5			2						25

Table H4 Bird Abundance by Habitat Type

Species	Number of Birds Observed or Heard during Breeding Bird Survey																							
	Habitats																							
	Mature Softwood	Immature Softwood	Mature Mixedwood	Immature Mixedwood	Mature Hardwood	Immature Hardwood	Clear Cut	Tallshrub Thicket	Lowshrub Thicket	Disturbed Area	Residential Area	Abandoned Pasture	Pasture	Agricultural Land	Tallshrub Swamp	Lowshrub Swamp	Coniferous Treed Swamp	Mixedwood Treed Swamp	Fresh Marsh	Brackish Marsh	Open Water	Habitat Unknown	Flew Over	
	MS	IS	MM	IM	MH	IH	CC	TT	LT	DA	RA	AP	PA	AL	TS	LS	CTS	MTS	FM	BM	OW	HU	FO	Total
Boreal Chickadee		3	2																					5
Red-breasted Nuthatch															3		1							4
Brown Creeper				1																				1
Golden-crowned Kinglet	3		1	1																				5
Ruby-crowned Kinglet	3		2	4											1									10
Veery			1	1				1																3
Swainson's Thrush	1																							1
Hermit Thrush	1		1			3																		5
American Robin	4	1	3	17	3	8		6			3	2			3			2				1	2	55
Cedar Waxwing				15		7		9				1			10		1	3					5	51
European Starling											12			15									7	34
Blue-headed Vireo	7	1	2	1											1			1						13
Red-eyed Vireo	1		5	11	2	15		8							1									43
Tennessee Warbler															1									1
Nashville Warbler	1					1									1									3
Northern Parula Warbler	6		5	1	1	2																		15
Yellow Warbler				3		2		22			2													29
Chestnut-sided Warbler				1	2	5		1																9

Table H4 Bird Abundance by Habitat Type

Species	Number of Birds Observed or Heard during Breeding Bird Survey																						
	Habitats																						
	Mature Softwood	Immature Softwood	Mature Mixedwood	Immature Mixedwood	Mature Hardwood	Immature Hardwood	Clear Cut	Tallshrub Thicket	Lowshrub Thicket	Disturbed Area	Residential Area	Abandoned Pasture	Pasture	Agricultural Land	Tallshrub Swamp	Lowshrub Swamp	Coniferous Treed Swamp	Mixedwood Treed Swamp	Fresh Marsh	Brackish Marsh	Open Water	Habitat Unknown	Flew Over	
	MS	IS	MM	IM	MH	IH	CC	TT	LT	DA	RA	AP	PA	AL	TS	LS	CTS	MTS	FM	BM	OW	HU	FO	Total
Magnolia Warbler	2	2	1	4		5		1							2									17
Yellow-rumped Warbler	6			4		2									1									13
Black-throated Green Warbler	5		2	2		3																		12
Blackburnian Warbler	2		1		1	2																		6
Palm Warbler		2																						2
Black-and-white Warbler	2	1	4	1		7									2									16
American Redstart					1	4		4							1									10
Ovenbird	3		7	1	2	3									1									17
Northern Waterthrush								3							1									4
Common Yellowthroat		2		2		8		3	3						8	2	1							29
Canada Warbler																	1							1
Rose-breasted Grosbeak								1																1
Chipping Sparrow				2		1		3			1								1					8
Savannah Sparrow											2	1	1	6										10
Nelson's Sharp-tailed Sparrow																				2				2
Song Sparrow		4	1	4		4		23	4		3	9		1	1	1						1		56
Lincoln's Sparrow		1																						1
Swamp Sparrow								3							3	3				1				10

Table H4 Bird Abundance by Habitat Type

Species	Number of Birds Observed or Heard during Breeding Bird Survey																						
	Habitats																						
	Mature Softwood	Immature Softwood	Mature Mixedwood	Immature Mixedwood	Mature Hardwood	Immature Hardwood	Clear Cut	Tallshrub Thicket	Lowshrub Thicket	Disturbed Area	Residential Area	Abandoned Pasture	Pasture	Agricultural Land	Tallshrub Swamp	Lowshrub Swamp	Coniferous Treed Swamp	Mixedwood Treed Swamp	Fresh Marsh	Brackish Marsh	Open Water	Habitat Unknown	Flew Over	
	MS	**IS**	**MM**	**IM**	**MH**	**IH**	**CC**	**TT**	**LT**	**DA**	**RA**	**AP**	**PA**	**AL**	**TS**	**LS**	**CTS**	**MTS**	**FM**	**BM**	**OW**	**HU**	**FO**	**Total**
White-throated Sparrow		3	1	10		9	4	3	1			1			2		1	1				2		38
Dark-eyed Junco	3	3	2	6		3	2																	19
Bobolink													3											3
Red-winged Blackbird				4				1											9				1	15
Common Grackle						3		5			2			9	3		2	3					29	56
Brown-headed Cowbird				1																				1
Purple Finch	2		1									1			3									7
American Goldfinch			2	6		5					4				6		2	2					9	36
Evening Grosbeak			2															1						3
House Sparrow											1			4										5
Total	61	25	52	119	15	139	7	122	9	2	41	15	4	58	80	6	9	19	10	3	8	8	90	902
Species Richness	22	13	25	28	10	27	3	23	4	2	12	6	2	10	32	3	7	11	2	2	3	6	19	

TABLE H5 Vascular Plant Species Found In the Study Area		
Category	**Binomial**	**Common Name**
Trees	*Abies balsamea*	Balsam fir
Trees	*Acer platanoides*	Norway maple
Trees	*Acer rubrum*	Red maple
Trees	*Acer saccharum*	Sugar maple
Trees	*Betula alleghenensis*	Yellow birch
Trees	*Betula cordifolia*	Mountain white birch
Trees	*Betula papyrifera*	White birch
Trees	*Betula populifolia*	Wire birch
Trees	*Fraxinus americana*	White ash
Trees	*Fraxinus nigra*	Black Ash
Trees	*Larix laricina*	Tamarack
Trees	*Ostrya virginiana*	Hop-hornbeam
Trees	*Picea glauca*	White spruce
Trees	*Picea mariana*	Black spruce
Trees	*Picea rubens*	Red spruce
Trees	*Pinus strobus*	White pine
Trees	*Populus grandidentata*	Large-tooth aspen
Trees	*Populus tremuloides*	Trembling aspen
Trees	*Prunus serotina*	Black cherry
Trees	*Pyrus malus*	Apple
Trees	*Quercus rubra*	Red oak
Trees	*Sorbus americana*	Mountain-ash
Trees	*Sorbus aucuparia*	Rowan
Trees	*Robinia pseudoacacia*	Black locust
Trees	*Tsuga canadensis*	Eastern hemlock
Trees	*Ulmus americana*	White elm
Shrubs	*Alnus incana*	Speckled alder
Shrubs	*Amelanchier laevis*	Smooth Serviceberry
Shrubs	*Amelanchier sp.*	Shadbush
Shrubs	*Aronia arbutifolia*	Red chokeberry
Shrubs	*Aronia melanocarpa*	Black chokeberry
Shrubs	*Chamaedaphne calyculata*	Leather leaf
Shrubs	*Cornus sericea*	Red-osier dogwood
Shrubs	*Corylus cornuta*	Beaked hazelnut
Shrubs	*Crataegus brainerdii*	Hawthorn
Shrubs	*Crataegus monogyna*	English hawthorn
Shrubs	*Crataegus sp.*	Hawthorn
Shrubs	*Diervilla lonicera*	Bush honeysuckle
Shrubs	*Gaylussacia baccata*	Huckleberry
Shrubs	*Ilex verticillata*	Black alder
Shrubs	*Kalmia angustifolia*	Lambkill
Shrubs	*Ledum groenlandicum*	Labrador tea
Shrubs	*Lonicera caerulea*	Mountain fly-honeysuckle
Shrubs	*Lonicera canadesis*	American fly-honeysuckle
Shrubs	*Lonicera tartarica*	Tartarian honeysuckle
Shrubs	*Myrica gale*	Sweet gale
Shrubs	*Myrica pensylvanica*	Bayberry
Shrubs	*Nemopanthus mucronata*	False holly
Shrubs	*Prunus pensylvanica*	Pin-cherry
Shrubs	*Prunus virginiana*	Choke-cherry
Shrubs	*Rhamnus frangula*	Buckthorn
Shrubs	*Rhododendron canadense*	Rhodora
Shrubs	*Ribes glandulosum*	Skunk-currant

TABLE H5 Vascular Plant Species Found In the Study Area

Category	Binomial	Common Name
Shrubs	*Ribes hirtellum*	Gooseberry
Shrubs	*Ribes lacustre*	Bristly black currant
Shrubs	*Ribes triste*	Wild red currant
Shrubs	*Rosa multiflora*	Multiflora rose
Shrubs	*Rosa nitida*	Swamp-rose
Shrubs	*Rosa virginiana*	Common wild rose
Shrubs	*Rubus allegheniensis*	Blackberry
Shrubs	*Rubus canadensis*	Smooth blackberry
Shrubs	*Rubus hispidus*	Trailing blackberry
Shrubs	*Rubus idaeus*	Garden raspberry
Shrubs	*Rubus setosus*	Blackberry
Shrubs	*Salix bebbiana*	Beaked willow
Shrubs	*Salix discolor*	Pussy-willow
Shrubs	*Salix eriocephala*	Willow
Shrubs	*Salix humilis*	Small pussy-willow
Shrubs	*Salix lucida*	Shining willow
Shrubs	*Salix pyrifolia*	Bog willow
Shrubs	*Sambucus canadensis*	Common elder
Shrubs	*Sambucus racemosa*	Red-berried elder
Shrubs	*Spiraea alba*	Meadowsweet
Shrubs	*Taxus canadensis*	Yew
Shrubs	*Toxicodendron rydbergii*	Western Poison Ivy
Shrubs	*Vaccinium angustifolium*	Late lowbush blueberry
Shrubs	*Vaccinium macrocarpon*	Large cranberry
Shrubs	*Vaccinium myrtilloides*	Canada blueberry
Shrubs	*Vaccinium oxycoccos*	Small cranberry
Shrubs	*Viburnum nudum*	Witherod
Shrubs	*Viburnum opulus*	Highbush-cranberry
Ground Vegetation	*Achillea millefolium*	Yarrow
Ground Vegetation	*Achillea ptarmica*	Sneezeweed
Ground Vegetation	*Actaea rubra*	Red baneberry
Ground Vegetation	*Agrimonia striata*	Agrimonia
Ground Vegetation	*Agrostis capillaris*	Bent-grass
Ground Vegetation	*Agrostis gigantea*	Red-top
Ground Vegetation	*Agrostis hyemalis*	Tickle-grass
Ground Vegetation	*Agrostis perennans*	Bent-grass
Ground Vegetation	*Agrostis stolonifera*	Creeping bent-grass
Ground Vegetation	*Alisma triviale*	Water plantain
Ground Vegetation	*Ambrosia artemisiifolia*	Common ragweed
Ground Vegetation	*Amphicarpaea bracteata*	Hog-peanut
Ground Vegetation	*Anaphalis margaratacea*	Pearly everlasting
Ground Vegetation	*Anthoxanthum odoratum*	Sweet vernal-grass
Ground Vegetation	*Apocynum cannabinum*	Indian hemp
Ground Vegetation	*Aralia hispida*	Bristly aralia
Ground Vegetation	*Aralia nudicaulis*	Wild sarsaparilla
Ground Vegetation	*Arctium minus*	Common burdock
Ground Vegetation	*Arisaema triphyllum*	Jack-in-the-pulpit
Ground Vegetation	*Asclepias incarnata*	Purple milkweed
Ground Vegetation	*Aster acuminatus*	Wood aster
Ground Vegetation	*Aster cordifolius*	Heart-leaved aster
Ground Vegetation	*Aster lanceolatus*	Aster
Ground Vegetation	*Aster lateriflorus*	Calico aster
Ground Vegetation	*Aster macrophyllus*	Large-leaved aster

TABLE H5 Vascular Plant Species Found In the Study Area

Category	Binomial	Common Name
Ground Vegetation	*Aster novae-angliae*	New England Aster
Ground Vegetation	*Aster novi-belgii*	New york aster
Ground Vegetation	*Aster puniceus*	Rough aster
Ground Vegetation	*Aster radula*	Aster
Ground Vegetation	*Aster umbellatus*	Tall white aster
Ground Vegetation	*Athyrium filix-femina*	Lady fern
Ground Vegetation	*Barbarea vulgaris*	Yellow rocket
Ground Vegetation	*Bidens cernua*	Nodding Bur-marigold
Ground Vegetation	*Bidens frondosa*	Beggar ticks
Ground Vegetation	*Brachyelytrum erectum*	Long-awned wood grass
Ground Vegetation	*Bromus ciliatus*	Brome grass
Ground Vegetation	*Bromus inermis*	Smooth brome-grass
Ground Vegetation	*Calamagrostis canadensis*	Blue-joint
Ground Vegetation	*Callitriche palustris*	Water-starwort
Ground Vegetation	*Calystegia sepium*	Bindweed
Ground Vegetation	*Cardamine pensylvanica*	Bitter-cress
Ground Vegetation	*Cardamine pratensis*	Cuckoo flower
Ground Vegetation	*Carduus crispus*	Welted Thistle
Ground Vegetation	*Carex aquatilis*	Sedge
Ground Vegetation	*Carex arctata*	Sedge
Ground Vegetation	*Carex atlantica*	Sedge
Ground Vegetation	*Carex canescens*	Sedge
Ground Vegetation	*Carex debilis*	Sedge
Ground Vegetation	*Carex echinata*	Sedge
Ground Vegetation	*Carex flacca*	Sedge
Ground Vegetation	*Carex flava*	Sedge
Ground Vegetation	*Carex folliculata*	Sedge
Ground Vegetation	*Carex gracillima*	Sedge
Ground Vegetation	*Carex gynandra*	Sedge
Ground Vegetation	*Carex intumescens*	Sedge
Ground Vegetation	*Carex lasiocarpa*	Sedge
Ground Vegetation	*Carex leptalea*	Sedge
Ground Vegetation	*Carex leptonervia*	Sedge
Ground Vegetation	*Carex lurida*	Sedge
Ground Vegetation	*Carex nigra*	Sedge
Ground Vegetation	*Carex pallescens*	Sedge
Ground Vegetation	*Carex panicea*	Sedge
Ground Vegetation	*Carex paupercula*	Sedge
Ground Vegetation	*Carex projecta*	Sedge
Ground Vegetation	*Carex pseudo-cyperus*	Sedge
Ground Vegetation	*Carex scoparia*	Sedge
Ground Vegetation	*Carex stipata*	Sedge
Ground Vegetation	*Carex stricta*	Sedge
Ground Vegetation	*Carex trisperma*	Sedge
Ground Vegetation	*Centaurea nigra*	Knapweed
Ground Vegetation	*Cerastium vulgatum*	Mouse-ear chickweed
Ground Vegetation	*Ceratophyllum demersum*	Hornwort
Ground Vegetation	*Chelone glabra*	Turtlehead
Ground Vegetation	*Chenopodium album*	Lamb's-quarters
Ground Vegetation	*Chrysanthemum leucanthemum*	Ox-eye daisy
Ground Vegetation	*Chrysosplenum americanum*	Golden saxifrage
Ground Vegetation	*Cicuta bulbifera*	Bulbous water-hemlock
Ground Vegetation	*Cicuta maculata*	Water-hemlock

TABLE H5 Vascular Plant Species Found In the Study Area

Category	Binomial	Common Name
Ground Vegetation	*Cinna latifolia*	Wood-reed
Ground Vegetation	*Circaea alpina*	Small enchanter's night-shade
Ground Vegetation	*Circaea lutetiana*	Enchanter's nightshade
Ground Vegetation	*Cirsium arvense*	Canada thistle
Ground Vegetation	*Cirsium vulgare*	Bull Thistle
Ground Vegetation	*Clematis virginiana*	Virgin's-bower
Ground Vegetation	*Clintonia borealis*	Yellow clintonia
Ground Vegetation	*Conyza canadensis*	Horseweed
Ground Vegetation	*Coptis trifolia*	Goldthread
Ground Vegetation	*Cornus canadensis*	Bunchberry
Ground Vegetation	*Corydalis sempervirens*	Pink corydalis
Ground Vegetation	*Cypripedium acaule*	Common lady's-slipper
Ground Vegetation	*Dactylis glomerata*	Orchard Grass
Ground Vegetation	*Danthonia spicata*	Poverty grass
Ground Vegetation	*Daucus carota*	Wild carrot
Ground Vegetation	*Dennstaedtia punctilobula*	Hay-scented fern
Ground Vegetation	*Drosera intermedia*	Narrow-leaved sundew
Ground Vegetation	*Drosera rotundifolia*	Round-leaved sundew
Ground Vegetation	*Dryopteris carthusiana*	Spinulose wood fern
Ground Vegetation	*Dryopteris cristata*	Crested wood fern
Ground Vegetation	*Dryopteris intermedia*	Evergreen Wood Fern
Ground Vegetation	*Dryopteris marginalis*	Marginal fern
Ground Vegetation	*Dulichium arundinaceum*	Dulichium
Ground Vegetation	*Echinocystus lobata*	Wild cucumber
Ground Vegetation	*Eleocharis acicularis*	Spike rush
Ground Vegetation	*Eleocharis ovata*	Spike rush
Ground Vegetation	*Eleocharis palustris*	Spike rush
Ground Vegetation	*Elymus repens*	Couch grass
Ground Vegetation	*Elymus virginicus*	Wild rye
Ground Vegetation	*Epigaea repens*	Trailing arbutus
Ground Vegetation	*Epilobium angustifolium*	Fireweed
Ground Vegetation	*Epilobium ciliatum*	Willowherb
Ground Vegetation	*Epilobium leptophyllum*	Willow-herb
Ground Vegetation	*Epilobium palustre*	Willow-herb
Ground Vegetation	*Equisetum arvense*	Field horsetail
Ground Vegetation	*Equisetum fluviatile*	Water horsetail
Ground Vegetation	*Equisetum sylvaticum*	Wood horsetail
Ground Vegetation	*Erectites hieracifolia*	Fireweed
Ground Vegetation	*Erigeron strigosus*	Daisy fleabane
Ground Vegetation	*Eriophorum virginicum*	Cotton-grass
Ground Vegetation	*Eupatorium maculatum*	Joe-pye-weed
Ground Vegetation	*Eupatorium perfoliatum*	Boneset
Ground Vegetation	*Euphrasia officinalis*	Common eyebright
Ground Vegetation	*Euthamia graminifolia*	Narrow-leaved goldenrod
Ground Vegetation	*Festuca filiformis*	Hair fescue
Ground Vegetation	*Festuca rubra*	Red fescue
Ground Vegetation	*Fragaria virginiana*	Wild strawberry
Ground Vegetation	*Galeopsis tetrahit*	Hemp-nettle
Ground Vegetation	*Galium asprellum*	Rough bedstraw
Ground Vegetation	*Galium palustre*	Marsh bedstraw
Ground Vegetation	*Galium tinctorium*	Small bedstraw
Ground Vegetation	*Gaultheria hispidula*	Snowberry
Ground Vegetation	*Gaultheria procumbens*	Teaberry

TABLE H5 Vascular Plant Species Found In the Study Area

Category	Binomial	Common Name
Ground Vegetation	*Geum aleppicum*	Avens
Ground Vegetation	*Geum laciniatum*	Avens
Ground Vegetation	*Geum macrophyllum*	Avens
Ground Vegetation	*Geum sp.*	Avens
Ground Vegetation	*Glechoma hederacea*	Gill-over-the-ground
Ground Vegetation	*Glyceria borealis*	Northern manna-grass
Ground Vegetation	*Glyceria canadensis var. laxa*	Rattlesnake grass
Ground Vegetation	*Glyceria grandis*	Reed manna-grass
Ground Vegetation	*Glyceria striata var. stricta*	Fowl manna-grass
Ground Vegetation	*Gnaphalium uliginosum*	Low cudweed
Ground Vegetation	*Gymnocarpium dryopteris*	Oak fern
Ground Vegetation	*Heracleum lanatum*	Cow parsnip
Ground Vegetation	*Hesperis matronalis*	Dames rocket
Ground Vegetation	*Hieracium aurantiacum*	Orange hawkweed
Ground Vegetation	*Hieracium caespitosum*	Hawkweed
Ground Vegetation	*Hieracium lachenalii*	Hawkweed
Ground Vegetation	*Hieracium pillosella*	Mouse-ear hawkweed
Ground Vegetation	*Hieracium piloselloides*	King devil / hawkweed
Ground Vegetation	*Hieracium scabrum*	Rough hawkweed
Ground Vegetation	*Hordeum jubatum*	Fox-tail Barley
Ground Vegetation	*Hydrocotyle americana*	Water-pennywort
Ground Vegetation	*Hypericum canadense*	St. john's-wort
Ground Vegetation	*Hypericum ellipticum*	St. John's-wort
Ground Vegetation	*Hypericum mutilum*	St. John's-wort
Ground Vegetation	*Hypericum perforatum*	Common st. john's-wort
Ground Vegetation	*Impatiens capensis*	Spotted touch-me-not
Ground Vegetation	*Iris versicolor*	Blue-flag
Ground Vegetation	*Juncus brevicaudatus*	Rush
Ground Vegetation	*Juncus canadensis*	Rush
Ground Vegetation	*Juncus effusus*	Soft rush
Ground Vegetation	*Juncus filiformis*	Rush
Ground Vegetation	*Juncus pelocarpus*	Rush
Ground Vegetation	*Juncus tenuis*	Rush
Ground Vegetation	*Lactuca canadensis*	Wild lettuce
Ground Vegetation	*Laportea canadensis*	Wood-nettle
Ground Vegetation	*Lapsana communis*	Nipplewort
Ground Vegetation	*Leersia oryzoides*	Rice cut-grass
Ground Vegetation	*Lemna minor*	Lesser duckweed
Ground Vegetation	*Leontodon autumnalis*	Fall dandelion
Ground Vegetation	*Lilium canadense*	Canada lily
Ground Vegetation	*Linaria vulgaris*	Butter-and-eggs
Ground Vegetation	*Linnaea borealis*	Twin-flower
Ground Vegetation	*Lobelia inflata*	Indian-tobacco
Ground Vegetation	*Lotus corniculatus*	Bird's-foot-trefoil
Ground Vegetation	*Ludwigia palustris*	False loosestrife
Ground Vegetation	*Luzula acuminata*	Woodrush
Ground Vegetation	*Luzula multiflora*	Common woodrush
Ground Vegetation	*Lycopodium annotinum*	Bristly club-moss
Ground Vegetation	*Lycopodium clavatum*	Club-moss
Ground Vegetation	*Lycopodium obscurum*	Ground pine
Ground Vegetation	*Lycopus americanus*	Water-horehound
Ground Vegetation	*Lycopus uniflorus*	Bugle weed
Ground Vegetation	*Lysimachia ciliata*	Fringed loosestrife

TABLE H5 Vascular Plant Species Found In the Study Area

Category	Binomial	Common Name
Ground Vegetation	*Lysimachia nummularia*	Moneywort
Ground Vegetation	*Lysimachia terrestris*	Yellow candle
Ground Vegetation	*Lysimachia thyrsiflora*	Water Loosestrife
Ground Vegetation	*Lythrum salicaria*	Purple Loosestrife
Ground Vegetation	*Maianthemum canadense*	Wild lily-of-the valley
Ground Vegetation	*Matricaria maritima*	Mayweed
Ground Vegetation	*Matricaria matricarioides*	Pineapple-weed
Ground Vegetation	*Medicago lupulina*	Black Medic
Ground Vegetation	*Medicago sativa*	Alfalfa
Ground Vegetation	*Melilotus alba*	White sweet-clover
Ground Vegetation	*Mentha arvensis*	Field-mint
Ground Vegetation	*Mitchella repens*	Partridge-berry
Ground Vegetation	*Mitella nuda*	Miterwort
Ground Vegetation	*Monotropa uniflora*	Indian pipe
Ground Vegetation	*Myosotis laxa*	Small forget-me-not
Ground Vegetation	*Nuphar variegatum*	Cow-lily
Ground Vegetation	*Odontites serotina*	Red Bartsia
Ground Vegetation	*Oenothera biennis*	Evening primrose
Ground Vegetation	*Oenothera parviflora*	Small-flowered evening-primrose
Ground Vegetation	*Onoclea sensibilis*	Sensitive fern
Ground Vegetation	*Oryzopsis asperifolia*	Rich-grass
Ground Vegetation	*Osmunda cinnamomea*	Cinnamon fern
Ground Vegetation	*Osmunda claytoniana*	Interrupted fern
Ground Vegetation	*Osmunda regalis*	Royal fern
Ground Vegetation	*Oxalis stricta*	Yellow wood-sorrel
Ground Vegetation	*Panicum boreale*	Panic grass
Ground Vegetation	*Pastinaca sativa*	Wild Parsnip
Ground Vegetation	*Phalaris arundinacea*	Reed canary-grass
Ground Vegetation	*Phegopteris connectilis*	Northern beech fern
Ground Vegetation	*Phleum pratense*	Timothy
Ground Vegetation	*Plantago lanceolata*	English plantain
Ground Vegetation	*Plantago major*	Broad-leaved plantain
Ground Vegetation	*Platanthera clavellata*	Fringed orchid
Ground Vegetation	*Platanthera dilatata*	White bog-orchid
Ground Vegetation	*Platanthera grandiflora*	Large purple fringed orchid
Ground Vegetation	*Platanthera lacera*	Ragged-fringed orchid
Ground Vegetation	*Platanthera psycodes*	Purple fringed orchid
Ground Vegetation	*Poa compressa*	Canada bluegrass
Ground Vegetation	*Poa palustris*	Meadow-grass
Ground Vegetation	*Poa pratensis*	Kentucky bluegrass
Ground Vegetation	*Polygonum amphibium*	Water Smartweed
Ground Vegetation	*Polygonum aviculare*	Knotweed
Ground Vegetation	*Polygonum convolvulus*	Wild buckwheat
Ground Vegetation	*Polygonum hydropiper*	Water-pepper
Ground Vegetation	*Polygonum hydropiperoides*	Mild Water-pepper
Ground Vegetation	*Polygonum lapathifolium*	Knotweed
Ground Vegetation	*Polygonum pensylvanicum*	Pinkweed
Ground Vegetation	*Polygonum persicaria*	Lady's thumb
Ground Vegetation	*Polygonum punctatum*	Water-smartweed
Ground Vegetation	*Polygonum robustius*	Knotweed
Ground Vegetation	*Polygonum sagittatum*	Tear-thumb
Ground Vegetation	*Polygonum sp.*	Knotweed
Ground Vegetation	*Potamogeton epihydrus*	Pondweed

TABLE H5 Vascular Plant Species Found In the Study Area

Category	Binomial	Common Name
Ground Vegetation	*Potamogeton foliosus*	Leafy Pondweed
Ground Vegetation	*Potamogeton richardsonii*	Redhead Pondweed
Ground Vegetation	*Potamogeton sp.*	Pondweed
Ground Vegetation	*Potentilla norvegica*	Rough cinquefoil
Ground Vegetation	*Potentilla palustris*	Marsh cinquefoil
Ground Vegetation	*Potentilla recta*	Sulphur cinquefoil
Ground Vegetation	*Potentilla simplex*	Cinquefoil
Ground Vegetation	*Prenanthes altissima*	Tall white lettuce
Ground Vegetation	*Prenanthes trifoliolata*	Gall-of-the-earth
Ground Vegetation	*Proserpinaca palustris*	Mermaid-weed
Ground Vegetation	*Prunella vulgaris*	Heal-all
Ground Vegetation	*Pteridium aquilinum*	Bracken fern
Ground Vegetation	*Pteritis pensylvanica*	Ostrich fern
Ground Vegetation	*Puccinellia distans*	Puccinellia
Ground Vegetation	*Pyrola elliptica*	Shinleaf
Ground Vegetation	*Ranunculus acris*	Tall buttercup
Ground Vegetation	*Ranunculus aquatilis*	White Water-crowfoot
Ground Vegetation	*Ranunculus repens*	Creeping buttercup
Ground Vegetation	*Rhinanthus crista-galli*	Yellow rattle
Ground Vegetation	*Rhyncospora alba*	Beak rush
Ground Vegetation	*Rorippa palustris*	Marsh cress
Ground Vegetation	*Rubus pubescens*	Dewberry
Ground Vegetation	*Rumex acetosella*	Sheep-sorrel
Ground Vegetation	*Rumex crispus*	Curled dock
Ground Vegetation	*Rumex obtusifolius*	Blunt-leaved dock
Ground Vegetation	*Rumex orbiculatus*	Water-dock
Ground Vegetation	*Sagittaria latifolia*	Common Arrowhead
Ground Vegetation	*Sanguinaria canadensis*	Bloodroot
Ground Vegetation	*Saponaria officinalis*	Bouncing-bet
Ground Vegetation	*Scirpus atrovirens*	Bulrush
Ground Vegetation	*Scirpus cyperinus*	Bulrush
Ground Vegetation	*Scirpus microcarpus*	Bulrush
Ground Vegetation	*Scirpus subterminalis*	Bulrush
Ground Vegetation	*Scirpus validus*	Bulrush
Ground Vegetation	*Scutellaria galericulata*	Skullcap
Ground Vegetation	*Scutellaria lateriflora*	Skullcap
Ground Vegetation	*Sedum telephinum*	Live-forever
Ground Vegetation	*Senecio aureus*	Golden Ragwort
Ground Vegetation	*Senecio jacobaea*	Stinking willy
Ground Vegetation	*Senecio robbinsii*	Swamp-ragwort
Ground Vegetation	*Senecio sylvaticus*	Ragwort
Ground Vegetation	*Silene vulgaris*	Bladder-campion
Ground Vegetation	*Sisyrynchium montanum*	Blue-eyed grass
Ground Vegetation	*Sium suave*	Water-parsnip
Ground Vegetation	*Smilacina trifolia*	Three-leaved false solomon's seal
Ground Vegetation	*Solanum dulcamara*	Bittersweet
Ground Vegetation	*Solidago bicolor*	White goldenrod
Ground Vegetation	*Solidago canadensis*	Canada goldenrod
Ground Vegetation	*Solidago flexicaulis*	Wood-goldenrod
Ground Vegetation	*Solidago gigantea*	Goldenrod
Ground Vegetation	*Solidago juncea*	Early goldenrod
Ground Vegetation	*Solidago puberula*	Rough goldenrod
Ground Vegetation	*Solidago rugosa*	Rough goldenrod

TABLE H5 Vascular Plant Species Found In the Study Area

Category	Binomial	Common Name
Ground Vegetation	*Solidago uliginosa*	Bog-goldenrod
Ground Vegetation	*Sonchus arvensis*	Perennial sow-thistle
Ground Vegetation	*Sonchus arvensis*	Perennial Sow-thistle
Ground Vegetation	*Sparganium americanum*	Bur-reed
Ground Vegetation	*Sparganium angustifolium*	Bur-reed
Ground Vegetation	*Sparganium emersum*	Bur-reed
Ground Vegetation	*Sparganium sp.*	Bur-reed
Ground Vegetation	*Spartina pectinata*	Broad-leaf
Ground Vegetation	*Spirodela polyrhyza*	Duckweed
Ground Vegetation	*Stellaria borealis*	Northern stitchwort
Ground Vegetation	*Stellaria graminea*	Grass-leaved stitchwort
Ground Vegetation	*Taraxacum officinale*	Dandelion
Ground Vegetation	*Thalictrum pubescens*	Meadow-rue
Ground Vegetation	*Thelypteris noveboracensis*	New york fern
Ground Vegetation	*Thelypteris palustris*	Marsh fern
Ground Vegetation	*Tragopogon pratensis*	Goat's-beard
Ground Vegetation	*Triadenum fraserii*	Marsh St. John's-wort
Ground Vegetation	*Trientalis borealis*	Star flower
Ground Vegetation	*Triglochin maritima*	Arrow-grass
Ground Vegetation	*Trifolium arvense*	Rabbitfoot Clover
Ground Vegetation	*Trifolium campestre*	Low Hop Clover
Ground Vegetation	*Trifolium pratense*	Red clover
Ground Vegetation	*Trifolium repens*	Creeping white clover
Ground Vegetation	*Trillium cernuum*	Nodding trillium
Ground Vegetation	*Triosteum aurantiacum*	Horse Gentian
Ground Vegetation	*Tussilago farfara*	Coltsfoot
Ground Vegetation	*Typha angustifolia*	Narrow-leaved cat-tail
Ground Vegetation	*Typha latifolia*	Broad-leaved cat-tail
Ground Vegetation	*Utricularia vulgaris*	Bladderwort
Ground Vegetation	*Verbascum thapsus*	Common mullein
Ground Vegetation	*Veronica officinalis*	Common speedwell
Ground Vegetation	*Veronica scutellata*	Marsh-speedwell
Ground Vegetation	*Vicia cracca*	Tufted vetch
Ground Vegetation	*Vicia dasycarpa*	Vetch
Ground Vegetation	*Vicia sepium*	Hedge-vetch
Ground Vegetation	*Viola cucullata*	Blue violet
Ground Vegetation	*Viola macloskeyi*	Small white violet
Ground Vegetation	*Viola pubescens*	Yellow violet

APPENDIX I

WETLAND EVALUATIONS

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1.0 Introduction

In Nova Scotia, wetlands are protected by the NSDEL Wetlands Directive. Any loss of wetland requires preparation of a wetland evaluation to establish the value of the wetland in relation to the merits of the development. Wetland evaluations are required if a project will physically disturb a wetland or if the hydrology of the wetland will be altered by construction or operation of the project. Wetlands greater than two hectares in size are evaluated using the North American Wetlands Conservation Council (Canada) wetland evaluation technique. Wetlands less than two hectares in size can be evaluated using a ten-step evaluation process used by NSDEL.

The RoW for the proposed section of 100 Series Highway at Antigonish passes through 20 wetlands. Wetland surveys were conducted in all of these wetlands with the exception of Wetland 5 which had been infilled prior to wetland field surveys. The wetland surveys were conducted to provide the information required to conduct wetland evaluations for any of these wetlands which may be adversely affected by construction and operation of the highway. The wetland surveys collected a variety of information including the type of wetland and a description of its hydrology, a description of the wetland habitat types present in the wetland, inventories of vascular plants, birds, mammals, reptiles and amphibians present in the wetland, any evidence of anthropogenic use of the wetland, and any evidence of damage to the wetland caused by anthropogenic activities. The information collected for each wetland was derived largely from field surveys since there is little existing information for most wetlands in Nova Scotia. Each wetland was visited twice, once in June and once in August 2002. The sizes and locations of the wetlands were determined from 1:10,000 scale topographic mapping of the highway route and 1:10,000 scale air photography. The topographic mapping was used as the base mapping and the air photos in conjunction with the field surveys were used to more precisely define the boundaries of the wetlands. Wetland 19 did not appear on the topographic mapping and was delineated using the air photography. The location of the wetlands along the RoW are presented in Figure 5.4 (a and b) in the main portion of the EA report.

A summary of wetland characteristics have been provided in Table I1. The results of the vascular plant surveys conducted in each wetland are presented in Table I2. Wetland evaluations were conducted for all wetlands found within the RoW of the highway. Four of the 19 wetlands evaluated are greater than two hectares in size and were evaluated using the North American Wetlands Conservation Council (Canada) wetland evaluation technique. The remaining 15 wetlands were evaluated using the NSDEL ten-step evaluation process. The wetland evaluations are presented in the following text.

2.0 Wetland Descriptions

A summary description is provided for each of the 19 wetlands in Table I1 below. Table I2 lists the vascular plant species encountered in each wetland.

Table I1 Wetland Evaluations

Wetland 1

Wetland Type:	Wetland complex composed of stream marsh, low shrub dominated stream swamp, tall shrub dominated stream swamp, and mixedwood treed stream swamp.
Size:	11.23 ha
Dominant Vegetation:	Stream marsh (Type 1)
Trees:	None
Shrubs:	*Spiraea alba* <1 %
Ground Vegetation:	*Typha latifolia* 40 %, *Proserpinaca palustris* 25 %, *Cicuta bulbifera* 5 %, *Potentilla palustris* 2 %.
Dominant Vegetation:	Stream marsh (Type 2)
Trees:	None
Shrubs:	*Myrica gale* 6 %, *Spiraea alba* 5 %, *Alnus incana* 2 %.
Ground Vegetation:	*Carex canescens* 30 %, *Carex nigra* 25 %, *Carex echinata* 10 %, *Cicuta bulbifera* 8 %, *Scirpus cyperinus* 5 %.
Dominant Vegetation:	Low shrub dominated stream swamp (Type 1)
Trees:	None
Shrubs:	*Spiraea alba* 40 %, *Myrica gale* 10 %, *Salix pyrifolia* 3 %, *Alnus incana* 2 %.
Ground Vegetation:	*Carex echinata* 25 %, *Carex scoparia* 5 %, *Cicuta bulbifera* 2 %.
Dominant Vegetation:	Low shrub dominated stream swamp (Type 2)
Trees:	None
Shrubs:	*Myrica gale* 40 %, *Chamaedaphne calyculata* 10 %, *Spiraea alba* 5 %.
Ground Vegetation:	*Typha latifolia* 35 %, *Proserpinaca palustris* 10 %.
Dominant Vegetation:	Tall shrub dominated stream swamp
Trees:	None
Shrubs:	*Alnus incana* 50 %, *Spiraea alba* 5 %.
Ground Vegetation:	*Onoclea sensibilis* 20 %, *Calamagrostis canadensis* 15 %, *Glyceria canadensis* 7 %, *Cicuta bulbifera* 5 %, *Sium suave* 2 %.
Dominant Vegetation:	Mixedwood treed stream swamp

Table 11 Wetland Evaluations

Trees:	*Picea mariana* 20 %, *Acer rubrum* 5 %.
Shrubs:	*Alnus incana* 25 %, *Spiraea alba* 10 %, *Acer rubrum* 7 %.
Ground Vegetation:	*Sphagnum* spp. 90 %, *Osmunda cinnamomea* 40 %, *Calamagrostis canadensis* 10 %, *Carex trisperma* 10 %, *Bidens cernua* 1 %.
Vascular plant list:	See Table 12. Two uncommon vascular plant species, *Proserpinaca palustris* and *Lysimachia thyrsiflora* present. Both species are listed as S3 by ACCDC. Nova Scotia populations of both species are considered to be secure by NSDNR.
Wildlife:	No rare or sensitive species present.
Birds:	Common Snipe, Blue Jay, Cedar Waxwing, Blue-headed Vireo, Common Yellowthroat, Red-winged Blackbird, Swamp Sparrow, American Goldfinch.
Mammals:	Beaver, Red Squirrel, Varying Hare, White-tailed Deer.
Herpetiles:	Leopard Frog, Northern Spring Peeper, Green Frog.
Hydrology:	Probably has moderate value in regards to surface flow regulation (augments stream flows during dry periods and helps to control flooding by storing flood water and slowing the flow of water).
Anthropogenic uses:	A small portion of the wetland was infilled during construction of Highway 104.
Comments:	Receives potentially contaminated drainage from Highway 104.
Wetland 2	
Wetland Type:	Tall shrub basin swamp/basin marsh complex
Size:	0.42 ha.
Dominant Vegetation:	Tall shrub basin swamp
Trees:	*Picea glauca* 5%
Shrubs:	*Alnus incana* 70%
Ground Vegetation:	*Impatiens capensis* 20%, *Osmunda cinnamomea* 15%, *Onoclea sensibilis* 10 %, *Glyceria striata* 7%, and *Aster puniceus* 3%.
Dominant Vegetation	Basin marsh
Trees:	None
Shrubs:	*Alnus incana* 5%
Ground Vegetation:	*Typha latifolia* 40%, *Onoclea sensibilis* 30%, *Thelypteris palustris* 15%, *Solidago canadensis* 7%, and *Cicuta bulbifera* 5%.
Vascular plant list:	See Table 12. One uncommon vascular plant species, *Asclepias incarnata* present. *Asclepias incarnata* is listed as S3 by ACCDC. Nova Scotia population considered to be secure by NSDNR.

Table I1 **Wetland Evaluations**

Wildlife:	No rare or sensitive species present.
Birds:	Red-breasted Nuthatch, Ovenbird, Swamp Sparrow, and American Goldfinch
Mammals:	Racoon and White-tailed Deer
Herpetiles:	Northern Spring Peeper
Hydrology:	A small wetland located near the headwaters of a small brook. Appears to be a groundwater discharge site.
Anthropogenic uses:	None noted.
Comments:	Wetland is surrounded by roads. May receive contaminated drainage. Dry ephemeral pool present.

Wetland 3

Wetland Type:	Coniferous treed basin swamp/tall shrub basin swamp
Size:	0.95 ha.
Dominant Vegetation:	Coniferous treed basin swamp
Trees:	*Picea mariana* 15%, *Larix laricina* 7%, *Acer rubrum* 5%
Shrubs:	*Rubus hispidus* 15 %, *Spiraea alba* 7 %, *Alnus incana* 5%, *Nemopanthus mucronata* 2%, *Ilex verticillata* 2%
Ground Vegetation:	*Sphagnum spp.* 80%, *Carex echinata* 25%, *Eriophorum virginicum* 7 %, *Lysimachia terestris* 5 %, *Triadenum fraseri* 4 %, *Aster umbellatus* 2 %
Dominant Vegetation:	Tall shrub basin swamp
Trees:	*Picea mariana* <1 %, *Larix laricina* <1 %
Shrubs:	*Alnus incana* 60%, *Ilex verticillata* 20 %
Ground Vegetation:	*Sphagnum spp.* 30%, *Calamagrostis canadensis* 25 %, *Lycopus uniflorus* 10 %, *Glyceria canadensis* 10 %, *moss sp.* 10 %, *Osmunda cinnamomea* 5 %, *Smilacina trifolia* 5 %, *Galium sp.* 4 %
Vascular plant list:	See Table I2.
Wildlife:	No rare or sensitive species encountered.
Birds:	Common Grackle, American Goldfinch
Mammals:	White-tailed Deer
Herpetiles:	None
Hydrology:	Basin swamp with no inflow and poorly developed outflow. Headwater of tributary to West River. Probable groundwater discharge site.
Anthropogenic uses:	Some timber harvesting has occurred around the margins of the wetland.
Comments:	None

Table I1 Wetland Evaluations

Wetland 4	
Wetland Type:	Tall shrub basin swamp
Size:	0.71 ha.
Dominant Vegetation:	
Trees:	*Acer rubrum* 10%, *Picea glauca* 5%
Shrubs:	*Alnus incana* 60 %, *Rubus hispidus* 20 %, *Ilex verticillata* 10 %.
Ground Vegetation:	*Sphagnum* spp. 70 %, *Osmunda cinnamomea* 30 %, *Iris versicolor* 8 %, *Osmunda regalis* 5 %, *Carex trisperma* 2 %.
Vascular plant list:	See Table I2. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Black-capped Chickadee, Cedar Waxwing.
Mammals:	White-tailed Deer, Racoon, Striped Skunk, Varying Hare.
Herpetiles:	None
Hydrology:	Basin swamp at the headwater of a small stream. Probable groundwater discharge area.
Anthropogenic uses:	Timber harvesting has occurred in the area surrounding the wetland.
Comments:	None
Wetland 5	
Wetland Type:	Shallow anthropogenic pond which has recently been infilled.
Wetland 6	
Wetland Type:	Wetland complex composed of shallow basin marsh, tall shrub basin swamp, deciduous treed basin swamp
Size:	4.27 ha
Dominant Vegetation:	Shallow basin marsh (Type 1)
Trees:	None
Shrubs:	None
Ground Vegetation:	*Typha latifolia* 40 %, *Calamagrostis canadensis* 35 %, *Impatiens capensis* 5 %.
Dominant Vegetation:	Shallow basin marsh (Type 2)
Trees:	None
Shrubs:	None
Ground Vegetation:	*Calamagrostis canadensis* 90 %.
Dominant Vegetation:	Tall shrub basin swamp

Table I1 Wetland Evaluations

Trees:	*Acer rubrum* 1 %.
Shrubs:	*Alnus incana* 60 %, *Cornus sericea* 5 %, *Prunus virginiana* 2 %.
Ground Vegetation:	*Onoclea sensibilis* 30 %, *Calamagrostis canadensis* 20 %, *Impatiens capensis* 10 %.
Dominant Vegetation:	Deciduous treed basin swamp
Trees:	*Acer rubrum* 40 %.
Shrubs:	*Alnus incana* 5 %, *Acer rubrum* 5 %, *Spiraea alba* 2 %, *Ilex verticillata* 2 %.
Ground Vegetation:	*Osmunda cinnamomea* 70 %, *Carex gynandra* 10 %, *Calamagrostis canadensis* 8 %, *Impatiens capensis* 5 %.
Vascular plant list:	See Table I2. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Ruffed Grouse, Cedar Waxwing, American Robin, Swamp Sparrow, American Goldfinch.
Mammals:	Red Squirrel, White-tailed Deer, Racoon.
Herpetiles:	Northern Spring Peeper.
Hydrology:	The wetland receives surface water inflow from a developed area (residential and light industry) on the west side of Trunk 7. Water discharges from the wetland near Highway 104 and flows through the town of Antigonish. Drainage course through wetland poorly developed. A few small scattered pools at the time of the field survey. Wetland probably has moderate value in regards to surface flow regulation (augments stream flows during dry periods and helps to control flooding by storing flood water and slowing the flow of water).
Anthropogenic uses:	Timber harvesting conducted in the northwestern quarter of the wetland. Causeway has been constructed across the eastern end of the wetland.
Comments:	Receives potentially contaminated drainage from Highway 104, Trunk 7 and residential areas along Trunk 7.
Wetland 7	
Wetland Type:	Tall shrub basin swamp
Size:	0.09 ha.
Dominant Vegetation:	
Trees:	None
Shrubs:	*Alnus incana* 70 %, *Ilex verticillata* <1 %, *Picea glauca* <1 %
Ground Vegetation:	*Rubus pubescens* 17 %, *Sphagnum* spp. 15 %, *Osmunda cinnamomea* 10 %, *Glyceria striata 10 %*, *Onoclea sensibilis* 8 %, *Poa palustris* 7 %, *Calamagrostis canadensis* 5 %.

Table 11 Wetland Evaluations

Vascular plant list:	See Table 12. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Ruffed Grouse, American Goldfinch, Red-eyed Vireo, Black-and-white Warbler, Cedar Waxwing
Mammals:	White-tailed Deer
Herpetiles:	None encountered.
Hydrology:	The wetland receives surface water flow from a hay field to the west. This drainage appears to occur intermittently after precipitation events. Water discharges from the wetland into a small tributary of the West River. No surface water was present at the time of the field surveys (June 18 and August 20). Wetland does not appear to be a groundwater recharge site.
Anthropogenic uses:	None noted.
Comments:	Wetland may receive contaminants including pesticides, nutrients and sediment from the hay field.
Wetland 8	
Wetland Type:	Wetland complex composed of tall shrub basin swamp, and basin marsh.
Size:	0.42 ha.
Dominant Vegetation:	Tall shrub basin swamp
Trees:	*Larix laricina* 5 %, *Acer rubrum* 3 %, *Picea glauca* 1 %.
Shrubs:	*Alnus incana* 40 %, *Spiraea alba* 30 %, *Rubus hispidus* 5 %.
Ground Vegetation:	*Sphagnum* spp. 70 %, *Carex echinata* 10 %, *Solidago uliginosa* 5 %, *Dryopteris cristata* 2 %, *Viola cucculata* 1 %.
Dominant Vegetation:	Basin Marsh
Trees:	None
Shrubs:	*Alnus incana* 5 %, *Spiraea alba* 2 %.
Ground Vegetation:	*Dulichium arundinacea* 70 %, *Typha latifolia* 15 %, *Iris versicolor* 8 %, *Triadenum fraseri* 7 %, *Juncus canadensis* 5 %.
Vascular plant list:	See Table 12. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Northern Flicker, Black-capped Chickadee, Common Yellowthroat, American Goldfinch.
Mammals:	Racoon, Red Squirrel, White-tailed Deer.
Herpetiles:	Northern Spring Peeper.

Table I1 Wetland Evaluations

Hydrology:	Wetland forms the headwater for a small tributary which drains into the West River. No surface water present at time of survey. Probable groundwater discharge site.
Anthropogenic uses:	The basin marsh habitat appears to have been created by human activity.
Comments:	None.
Wetland 9	
Wetland Type:	Tall shrub basin swamp
Size:	0.31 ha.
Dominant Vegetation:	
Trees:	*Larix laricina* 5 %, *Picea glauca* 2 %
Shrubs:	*Alnus incana* 40 %, *Spiraea alba* 25 %.
Ground Vegetation:	*Carex nigra* 20 %, *Carex echinata* 20 %, *Solidago gigantea* 18 %, *Agrostis stolonifera* 15 %, *Carex panicea* 10 %, *Iris versicolor* 5 %.
Vascular plant list:	See Table I2. No rare species encountered.
Wildlife:	One provincially uncommon species, Boreal Chickadee, recorded.
Birds:	Ruby-crowned Kinglet, Boreal Chickadee, Cedar Waxwing, Yellow-rumped Warbler, Magnolia Warbler, Common Yellowthroat, Evening Grosbeak.
Mammals:	Red Squirrel, White-tailed Deer
Herpetiles:	None noted.
Hydrology:	Basin swamp which forms the headwater for a small tributary which drains into the West River. No surface water present at time of survey. Probable groundwater discharge site.
Anthropogenic uses:	None noted.
Comments:	None.
Wetland 10	
Wetland Type:	Wetland complex composed of tall shrub stream swamp, and stream marsh.
Size:	0.50 ha.
Dominant Vegetation:	Tall shrub stream swamp
Trees:	None
Shrubs:	*Alnus incana* 70 %, *Ilex verticillata* 5 %.
Ground Vegetation:	*Sphagnum* spp. 60%, *Onoclea sensibilis* 10 %, *Agrostis stolonifera* 7 %, *Impatiens capensis* 5 %, *Polygonum sagittat*um 2 %, *Polygonum robustius* 2 %.

Table 11 Wetland Evaluations

Dominant Vegetation:	Stream marsh
Trees:	None
Shrubs:	None
Ground Vegetation:	*Juncus canadensis, Agrostis stolonifera, Leersia oryzoides, Eleocharis obtusa, Scirpus cyperinus.* (Cover estimates unavailable).
Vascular Plant List:	See Table I2. One uncommon species, marsh mermaid-weed (*Proserpinaca palustris*) was found in the wetland. This species is rated S3 by ACCDC and Nova Scotia population is considered secure by NSDNR.
Wildlife:	No rare or sensitive species encountered.
Birds:	Ruffed Grouse, Rock Dove, Northern Flicker, Black-capped Chickadee, Cedar Waxwing, Common Yellowthroat, American Goldfinch.
Mammals:	Racoon, Muskrat, White-tailed Deer.
Herpetiles:	Green Frog, Northern Leopard Frog, Northern Spring Peeper, probable breeding habitat for Yellow-spotted Salamander and Blue-spotted Salamander.
Hydrology:	The wetland has developed on the banks of a small stream which flows into the West River.
Anthrpogenic uses:	None noted
Comments:	Wetland is located within the highway RoW but not in the footprint of the road.

Wetland 11

Wetland Type:	Tall shrub stream swamp
Size:	2.93 ha.
Dominant Vegetation:	
Trees:	*Picea mariana* 8 %, *Abies balsamea* 5 %.
Shrubs:	*Alnus incana* 50 %, *Spiraea alba 15 %.*
Ground Vegetation:	*Senecio aurea* 20%, *Calamagrostis canadensis* 15 %, *Lysimachia ciliolata* 10 %, *Rubus pubescens* 5 %.
Vascular plant list:	See Table I2. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Belted Kingfisher, Red-breasted Nuthatch, Common Yellowthroat, Common Grackle, American Goldfinch.
Mammals:	Red Squirrel, Beaver, Racoon, White-tailed Deer.
Herpetiles:	Mink Frog, Green Frog, Leopard Frog.

Table 11 **Wetland Evaluations**

Hydrology:	Wetland has developed on the banks of an unnamed brook which flows into Antigonish Harbour. Wetland probably has moderate value in regards to surface flow regulation (augments stream flows during dry periods and helps to control flooding by storing flood water and slowing the flow of water).
Anthrpogenic uses:	None noted.
Comments:	None
Wetland 12	
Wetland Type:	Wetland complex composed of tall shrub stream swamp and coniferous treed stream swamp.
Size:	7.22 ha.
Dominant Vegetation:	Tall shrub stream swamp (in beaver flooding).
Trees:	*Acer rubrum* 2 %.
Shrubs:	*Alnus incana* (stressed) 40 %, *Abies balsamea* (dying) 10 %, *Cornus sericea* 2 %.
Ground Vegetation:	*Calamagrostis canadensis* 30 %, *Glyceria striata* 5 %, *Scirpus cyperinus* 2 %, *Carex viridula* 2 %.
Dominant Vegetation:	Tall shrub stream swamp (area not flooded).
Trees:	*Acer rubrum* 10 %, *Abies balsamea* 5 %, *Picea glauca* 5 %.
Shrubs:	*Alnus incana* 50 %, *Cornus sericea* 5 %, *Prunus virginiana* 1 %.
Ground Vegetation:	*Impatiens capensis* 40 %, *Onoclea sensibilis* 20 %, *Clematis virginiana* 15 %, *Eupatorium maculatum* 8 %, *Aster puniceus* 5 %, *Solidago gigantea* 5 %.
Dominant Vegetation:	Coniferous treed stream swamp (harvested).
Trees:	*Acer rubrum* 10 %, *Abies balsamea* 5 %.
Shrubs:	*Alnus incana* 25 %, *Ilex verticillata* 15 %, *Acer rubrum* 5 %.
Ground Vegetation:	*Osmunda cinnamomea* 60 %, *Sphagnum* spp. 40 %, *Rubus pubescens* 12 %, *Onoclea sensibilis* 10 %, *Eupatorium maculatum* 2 %.
Vascular plant list:	See Table 12. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Great Blue Heron, Common Snipe, American Woodcock, Mourning Dove, Belted Kingfisher, Ruby-throated Hummingbird, Northern Flicker, Hairy Woodpecker, Downy Woodpecker,Alder Flycatcher, Olive-sided Flycatcher, Cedar Waxwing, American Robin, Common Yellowthroat, Common Grackle, Song Sparrow, Purple Finch, American Goldfinch.
Mammals:	Meadow Vole, Beaver, Red Squirrel, Coyote, White-tailed Deer.
Herpetiles:	Northern Spring Peeper, Leopard Frog, Green Frog.

Table 11 Wetland Evaluations

Hydrology:	Wetland has developed on the banks of an unnamed brook which flows into Antigonish Harbour. Wetland probably has moderate value in regards to surface flow regulation (augments stream flows during dry periods and helps to control flooding by storing flood water and slowing the flow of water).
Anthrpogenic uses:	The northeastern quarter of the wetland has been clear-cut in the past few years.
Comments:	The western end of the wetland has been flooded by recent beaver activity which has created pools, killed trees and reduced amount of shrub cover. This has made this portion of the wetland attractive to fish eating birds such as Great Blue Heron and Belted Kingfisher, species which prefer more open wetland habitats such as Common Snipe and woodpeckers such as Northern Flicker, Hairy Woodpecker and Downy Woodpecker. The pools and wheel ruts from timber harvesting provide amphibian breeding habitat.

Wetland 13

Wetland Type:	Wetland Complex composed of mixedwood treed basin swamp and tall shrub basin swamp.
Size:	0.94 ha.
Dominant Vegetation:	Mixedwood treed basin swamp.
Trees:	*Acer rubrum* 50%, *Abies balsamea* 20 %, *Betula papyrifera* 5 %, *Fraxinus americana* 5 %.
Shrubs:	*Alnus incana* 25 %, *Cornus sericea* 5 %, *Abies balsamea* 2 %, *Ribes hirtellum* <1 %.
Ground Vegetation:	*Impatiens capensis* 30 %, *Osmunda cinnamomea* 25 %, *Rubus pubescens* 20 %, *Onoclea sensibilis* 15 %, *Aster puniceus* 5 %.
Dominant Vegetation:	Tall shrub basin swamp
Trees:	None
Shrubs:	*Alnus incana* 40 %, *Abies balsamea* 2 %.
Ground Vegetation:	*Impatiens capensis* 70 %, *Onoclea sensibilis* 15 %, *Polygonum sagittatum* 10 %, *Aster puniceus* 5 %, *Glyceria striata* 5 %.
Vascular plant list:	See Table 12. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Ruffed Grouse, Pileated Woodpecker, American Robin, White-throated Sparrow, American Goldfinch.
Mammals:	Deer Mouse, Red Squirrel, White-tailed Deer.
Herpetiles:	None

Table I1 Wetland Evaluations

Hydrology:	Basin swamp located along a small tributary to an unnamed stream which enters Antigonish Harbour. Probable groundwater discharge area.
Anthropogenic uses:	Some timber harvesting adjacent to wetland.
Comments:	None
Wetland 14	
Wetland Type:	Tall shrub basin swamp.
Size:	0.23 ha.
Dominant Vegetation:	Tall shrub basin swamp (undisturbed).
Trees:	*Abies balsamea* 3 %, *Picea glauca* 2 %.
Shrubs:	*Alnus incana* 60 %, *Ilex verticillata* 2 %, *Abies balsamea* <1 %.
Ground Vegetation:	*Onoclea sensibilis* 40 %, *Aster puniceus* 10 %, *Impatiens capensis* 8 %, *Solidago canadensis* 5 %, *Sphagnum* spp. 5 %.
Dominant Vegetation:	Tall shrub basin swamp (heavily disturbed).
Trees:	None
Shrubs:	*Alnus incana* <1 %, *Rubus idaeus* <1 %.
Ground Vegetation:	*Polygonum sagittatum* 40 %, *Carex lurida* 25 %, *Juncus effusus* 20 %, *Glyceria grandis* 15 %, *Scirpus microcarpus* 10 %.
Vascular plant list:	See Table I2. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Ruffed Grouse, Black-capped Chickadee, Red-breasted Nuthatch, Cedar Waxwing, Common Grackle, Common Yellowthroat, White-throated Sparrow, American Goldfinch.
Mammals:	Racoon, Varying Hare.
Herpetiles:	None observed.
Hydrology:	Basin swamp located along a small tributary of the South River. Probable groundwater discharge site.
Anthropogenic uses:	Merchantable timber in the wetland has been harvested. No other uses noted.
Comments:	None
Wetland 15	
Wetland Type:	Tall shrub stream swamp.
Size:	0.57 ha.
Dominant Vegetation:	
Trees:	*Acer rubrum* 2 %, *Picea mariana* 1 %.

Table I1 Wetland Evaluations

Shrubs:	*Alnus incana* 60 %, *Spiraea alba* <1 %.
Ground Vegetation:	*Sphagnum* spp. 35 % *Onoclea sensibilis* 30 %, *Onoclea sensibilis* 30 %, *Aster puniceus* 10 %, *Equisetum sylvaticum* 5 %, *Solidago gigantea* 5 %, *Dryopteris cristata* 3 %.
Vascular plant list:	See Table I2. One uncommon species, large purple-fringed orchid (*Platanthera grandiflora*), found in wetland. This species is classed as S3 by the ACCDC and the Nova Scotia population is considered secure by NSDNR.
Wildlife:	No rare or sensitive species encountered.
Birds:	Ruffed Grouse, Common Yellowthroat.
Mammals:	Red Squirrel, White-tailed Deer, Coyote.
Herpetiles:	Wood Frog, Northern Spring Peeper.
Hydrology:	Stream swamp located along an intermittent stream (not shown on topographic mapping). Probable groundwater discharge site.
Anthropogenic uses:	None noted.
Comments:	None.

Wetland 16

Wetland Type:	Coniferous treed basin swamp.
Size:	0.80 ha.
Dominant Vegetation:	
Trees:	*Picea mariana* 30 %, *Larix laricina* 5 %, *Acer rubrum* 2 %.
Shrubs:	*Nemopanthus mucronata* 35 %, *Ilex verticillata* 20 %, *Alnus incana* 10 %, *Viburnum nudum* 10 %, *Gaylussacia baccata* 10 %.
Ground Vegetation:	*Sphagnum* spp. 90 %, *Smilacina trifolia* 10 %, *Gaultheria hispidula* 2 %.
Vascular plant list:	See Table I2. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Ruffed Grouse, Red-breasted Nuthatch, Common Yellowthroat.
Mammals:	Red Squirrel, Varying Hare, White-tailed Deer.
Herpetiles:	Wood Frog, Northern Spring Peeper.
Hydrology:	Basin swamp located along a small tributary of the South River. Probable groundwater discharge site.
Anthropogenic uses:	None noted.
Comments:	None.

Table I1 Wetland Evaluations

Wetland 17

Wetland Type:	Tall shrub basin swamp.
Size:	0.71 ha.
Dominant Vegetation:	
Trees:	*Picea mariana* 1 %, *Betula populifolia* <1 %.
Shrubs:	*Ilex verticillata* 40 %, *Nemopanthus mucronata 15 %*, *Alnus incana* 15 %, *Spiraea alba* 15 %, *Viburnum nudum* 5 %.
Ground Vegetation:	*Sphagnum* spp. 80 %, *Smilacina trifolia* 10 %, *Osmunda cinnamomea* 2 %, *Dryopteris cristata* 1 %.
Vascular plant list:	See Table I2. One uncommon species, large purple-fringed orchid (*Platanthera grandiflora*), found in wetland. This species is classed as S3 by the ACCDC and the Nova Scotia population is considered secure by NSDNR.
Wildlife:	No rare or sensitive species encountered.
Birds:	Magnolia Warbler, Black-and-white Warbler, Common Yellowthroat, White-throated Sparrow.
Mammals:	Varying Hare, Coyote.
Herpetiles:	Maritime Garter Snake.
Hydrology:	Basin swamp located along an intermittent stream. Probable groundwater discharge site.
Anthropogenic uses:	None noted.
Comments:	None.

Wetland 18

Wetland Type:	Mixedwood treed basin swamp (clear-cut).
Size:	1.13 ha.
Dominant Vegetation:	
Trees:	*Acer rubrum* <1 %.
Shrubs:	*Betula populifolia* 20 %, *Gaylussacia baccata* 20 %, *Picea mariana* 18 %, *Kalmia angustifolia* 15 %, *Nemopanthus mucronata* 12 %, *Ledum groenlandicum* 10 %.
Ground Vegetation:	*Sphagnum* spp. 90 %, *Osmunda cinnamomea* 10 %, *Smilacina trifolia* 7 %, *Cornus canadensis* 5 %, *Scirpus cyperinus* 5 %.
Vascular plant list:	See Table I2. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Cedar Waxwing, White-throated Sparrow, American Goldfinch.

Table 11 Wetland Evaluations

Mammals:	None
Herpetiles:	Eastern Smooth Green Snake.
Hydrology:	Basin swamp located along a small intermittent stream. Probable groundwater discharge site.
Anthropogenic uses:	Merchantable timber in the wetland has been harvested. No other uses noted.
Comments:	Wetland is much smaller than portrayed on topographical mapping.
Wetland 19	
Wetland Type:	Wetland complex composed of mixedwood treed basin swamp and tall shrub basin swamp.
Size:	0.54 ha.
Dominant Vegetation:	Mixedwood treed basin swamp
Trees:	*Acer rubrum* 25 %, *Abies balsamea* 15 %, *Picea mariana* 5 %.
Shrubs:	*Alnus incana* 15 %, *Abies balsamea* 10 %.
Ground Vegetation:	*Glyceria striata* 25 %, *Rubus pubescens* 20 %, *Onoclea sensibilis* 6 %, *Equisetum sylvaticum* 5 %, *Cornus canadensis* 5 %, *Osmunda cinnamomea* 2 %.
Dominant Vegetation:	Tall shrub basin swamp
Trees:	*Picea glauca* 10 %, *Acer rubrum* 5 %, *Picea mariana* 2 %.
Shrubs:	*Alnus incana* 50 %, *Ilex verticillata* 5 %, *Rubus hispidus* 2 %.
Ground Vegetation:	*Rubus pubescens* 60 %, *Sphagnum* spp. 40 %, *Osmunda cinnamomea* 15 %, *Onoclea sensibilis* 5 %, *Solidago canadensis* 5 %.
Vascular plant list:	See Table 12. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Black-capped Chickadee, Cedar Waxwing.
Mammals:	Red Squirrel, Porcupine, Racoon.
Herpetiles:	Northern Spring Peeper.
Hydrology:	Basin swamp located along a small tributary to an unnamed stream. Probable groundwater discharge area.
Anthropogenic uses:	Some timber harvesting adjacent to wetland as well as blueberry fields.
Comments:	Wetland receives potentially contaminated runoff from ditches along Highway 104.

Table I1 Wetland Evaluations

Wetland 20

Wetland Type:	Mixedwood treed basin swamp
Size:	0.99 ha.
Dominant Vegetation:	
Trees:	*Picea mariana* 40 %, *Acer rubrum* 15 %, *Abies balsamea* 10 %, *Betula papyrifera* 5 %.
Shrubs:	*Ilex verticillata* 30 %, *Nemopanthus mucronata* 10 %, *Alnus incana* 15 %.
Ground Vegetation:	*Osmunda cinnamomea* 60 %, *Sphagnum* spp. 25 %, *Cornus canadensis* 5 %, *Maianthemum canadense* 2 %, *Coptis trifolia* 2 %.
Vascular plant list:	See Table I2. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Black-capped Chickadee, Blue Jay, American Robin, Cedar Waxwing, Evening Grosbeak, American Goldfinch.
Mammals:	Red Squirrel, White-tailed Deer, Striped Skunk, Racoon.
Herpetiles:	Green Frog, Wood Frog.
Hydrology:	Basin swamp located at headwaters of small intermittent stream. Probable groundwater discharge area.
Anthropogenic uses:	Some timber harvesting adjacent to wetland.
Comments:	Wetland not delineated on topographic mapping. Field identified and delineated using air photography.

Table I2 Vascular Plant Species Found in the Wetlands Present Within the Proposed Highway 104 Right-of-Way

Species		Wetland Identification Number (note: Wetland #5 has been infilled) p=present																		
Binomial	**Common Name**	1	2	3	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
						Trees														
Abies balsamea	Balsam fir		p			p					p	p	p	p			p	p	p	p
Acer rubrum	Red maple	p	p	p	p	p		p			p	p	p	p	p	p	p	p	p	p
Betula alleghemiensis	Yellow birch														p				p	
Betula cordifolia	Mountain white birch	p				p		p				p						p		
Betula papyrifera	White birch											p	p						p	p
Betula populifolia	Wire birch			p	p			p			p					p	p	p		
Fraxinus americana	White ash												p						p	
Fraxinus nigra	Black Ash																		p	
Larix laricina	Tamarack			p		p	p	p	p		p					p	p	p		
Ostrya virginiana	Hop-hornbeam											p								
Picea glauca	White spruce		p		p	p	p	p	p				p						p	
Picea mariana	Black spruce			p				p			p	p		p	p	p	p	p	p	p
Picea rubens	Red spruce											p								
Pinus strobus	White pine											p						p		
Populus tremuloides	Trembling aspen		p															p		
Prunus serotina	Black cherry											p								
						Shrubs														
Alnus incana	Speckled alder	p	p	p	p	p	p	p	p		p	p		p	p	p	p		p	p
Amelanchier sp.	Shadbush												p	p			p	p		
Aronia arbutifolia	Red chokeberry						p									p				
Aronia melanocarpa	Black chokeberry			p														p		
Chamaedaphne calyculata	Leather leaf	p																		
Cornus sericea	Red-osier dogwood	p	p			p			p	p	p	p	p							
Corylus cornuta	Beaked hazelnut											p								
Crataegus sp.	Hawthorn										p									
Diervilla lonicera	Bush honeysuckle										p									
Gaylussacia baccata	Huckleberry															p		p		
Ilex verticillata	Black alder	p	p	p	p	p	p	p		p	p	p		p	p	p	p		p	p
Kalmia angustifolia	Lambkill	p		p				p			p	p				p	p	p	p	
Ledum groenlandicum	Labrador tea							p								p	p	p		
Lonicera caerulea	Mountain fly-honeysuckle				p							p								
Lonicera canadesis	American fly-honeysuckle										p	p								
Myrica gale	Sweet gale	p																		
Myrica pensylvanica	Bayberry										p					p		p		
Nemopanthus mucronata	False holly	p									p					p	p	p		p
Prunus pensylvanica	Pin-cherry								p			p						p		

Table I2 Vascular Plant Species Found in the Wetlands Present Within the Proposed Highway 104 Right-of-Way																				
Species		**Wetland Identification Number (note: Wetland #5 has been infilled) p=present**																		
Binomial	**Common Name**	1	2	3	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Prunus virginiana	Choke-cherry		p									p	p							
Rhamnus frangula	Buckthorn							p												
Rhododendron canadense	Rhodora	p						p			p					p				
Ribes glandulosum	Skunk-currant		p																p	
Ribes hirtellum	Gooseberry		p	p		p	p				p	p	p						p	
Ribes lacustre	Bristly black currant												p							
Ribes triste	Wild red currant												p							
Rosa nitida	Swamp-rose	p	p	p		p	p		p	p		p	p	p	p	p	p		p	
Rosa virginiana	Common wild rose	p				p		p	p	p			p		p					
Rubus canadensis	Smooth blackberry						p								p					
Rubus hispidus	Trailing blackberry			p	p			p	p		p			p	p	p	p	p	p	
Rubus idaeus	Garden raspberry				p			p	p			p	p	p						
Rubus setosus	Blackberry										p							p		
Salix discolor	Pussy-willow	p										p	p					p		
Salix eriocephala	Willow		p			p						p							p	
Salix humilis	Small pussy-willow	p										p	p							
Salix pyrifolia	Bog willow	p	p	p	p	p										p	p			
Sambucus canadensis	Common elder					p			p		p	p					p		p	
Sambucus racemosa	Red-berried elder			p																
Spiraea alba	Meadowsweet	p		p		p	p	p	p		p	p			p	p	p			
Taxus canadensis	Yew											p								
Toxicodendron rydbergii	Western Poison Ivy										p	p								
Vaccinium angustifolium	Late lowbush blueberry										p				p	p		p		
Vaccinium macrocarpon	Large cranberry															p				
Vaccinium myrtilloides	Canada blueberry				p			p			p				p			p		p
Vaccinium oxycoccos	Small cranberry																	p		
Viburnum nudum	Witherod	p		p	p			p			p	p		p	p	p	p	p	p	p
Ground Vegetation																				
Achillea millefolium	Yarrow													p						
Achillea ptarmica	Sneezeweed																			
Actaea rubra	Red baneberry												p							
Agrimonia striata	Agrimonia					p														
Agrostis capillaris	Bent-grass																			
Agrostis gigantea	Red-top													p						
Agrostis hyemalis	Tickle-grass							p	p		p	p						p		
Agrostis perennans	Bent-grass		p						p		p	p	p	p	p					p
Agrostis stolonifera	Creeping bent-grass	p	p					p	p	p		p								

Table I2 Vascular Plant Species Found in the Wetlands Present Within the Proposed Highway 104 Right-of-Way

Species		Wetland Identification Number (note: Wetland #5 has been infilled) p=present																		
Binomial	**Common Name**	1	2	3	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Alisma triviale	Water plantain										p									
Ambrosia artemisiifolia	Common ragweed																			
Amphicarpaea bracteata	Hog-peanut																			
Anaphalis margaratacea	Pearly everlasting																			
Anthoxanthum odoratum	Sweet vernal-grass													p						
Apocynum cannabinum	Indian hemp																			
Aralia hispida	Bristly aralia																			
Aralia nudicaulis	Wild sarsaparilla		p					p			p	p	p	p					p	p
Arctium minus	Common burdock																			
Arisaema triphyllum	Jack-in-the-pulpit					p						p	p							
Asclepias incarnata	Swamp-milkweed		p																	
Aster acuminatus	Wood aster												p					p	p	
Aster cordifolius	Heart-leaved aster									p										
Aster lanceolatus	Aster	p				p				p			p							
Aster lateriflorus	Calico aster										p	p	p		p				p	
Aster macrophyllus	Large-leaved aster																			
Aster novae-angliae	New England Aster											p								
Aster novi-belgii	New york aster	p						p	p			p						p	p	
Aster puniceus	Rough aster		p	p		p	p			p	p	p	p	p	p				p	
Aster radula	Aster											p								
Aster umbellatus	Tall white aster	p	p	p	p	p	p	p	p		p	p	p	p			p	p	p	
Athyrium filix-femina	Lady fern		p			p						p	p		p				p	
Bidens cernua	Nodding Bur-marigold	p	p			p				p	p			p						
Bidens frondosa	Beggar ticks	p	p	p	p	p						p								
Brachyelytrum erectum	Long-awned wood grass	p										p							p	
Bromus ciliatus	Brome grass											p	p							
Bromus inermis	Smooth brome-grass																			
Calamagrostis canadensis	Blue-joint	p	p		p	p	p	p			p					p		p	p	p
Callitriche palustris	Water-starwort										p	p								
Calystegia sepium	Bindweed																			
Cardamine pensylvanica	Bitter-cress											p								
Carex aquatilis	Sedge														p					p
Carex atlantica	Sedge															p				
Carex canescens	Sedge	p																		p
Carex debilis	Sedge														p					
Carex echinata	Sedge	p		p	p	p		p	p	p	p	p	p		p			p	p	
Carex flava	Sedge										p	p								

Table 12 Vascular Plant Species Found in the Wetlands Present Within the Proposed Highway 104 Right-of-Way

Species		Wetland Identification Number (note: Wetland #5 has been infilled) p=present																		
Binomial	**Common Name**	**1**	**2**	**3**	**4**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Carex folliculata	Sedge																		p	
Carex gracillima	Sedge										p		p							
Carex gynandra	Sedge	p	p			p				p	p	p	p	p	p		p	p	p	
Carex intumescens	Sedge	p	p	p	p						p	p	p	p	p		p		p	p
Carex lasiocarpa	Sedge	p																		
Carex leptalea	Sedge												p							
Carex leptonervia	Sedge												p							
Carex lurida	Sedge					p				p	p	p	p	p	p		p	p	p	p
Carex nigra	Sedge	p		p	p			p	p			p	p			p	p		p	
Carex panicea	Sedge								p											
Carex paupercula	Sedge															p		p		
Carex projecta	Sedge							p				p	p						p	
Carex pseudo-cyperus	Sedge	p	p			p				p	p	p	p							
Carex scoparia	Sedge	p				p	p		p	p	p	p	p	p	p					
Carex stipata	Sedge	p		p	p	p	p					p	p	p	p		p		p	
Carex stricta	Sedge	p																		
Carex trisperma	Sedge	p		p	p	p	p					p	p	p	p	p	p	p	p	
Chelone glabra	Turtlehead	p	p			p				p		p	p						p	
Chrysosplenum americanum	Golden saxifrage		p				p					p	p							
Cicuta bulbifera	Bulbous water-hemlock	p	p							p										
Cicuta maculata	Water-hemlock			p		p				p										
Cinna latifolia	Wood-reed													p						p
Circaea alpina	Small enchanter's night-shade		p																	
Cirsium arvense	Canada thistle	p				p						p	p							
Cirsium vulgare	Bull Thistle										p	p								
Clematis virginiana	Virgin's-bower		p			p	p				p	p								
Coptis trifolia	Goldthread	p		p									p		p				p	p
Cornus canadensis	Bunchberry	p			p						p	p	p		p			p	p	p
Cypripedium acaule	Common lady's-slipper															p				
Dennstaedtia punctilobula	Hay-scented fern											p								
Drosera intermedia	Narrow-leaved sundew	p																		
Drosera rotundifolia	Round-leaved sundew	p																		
Dryopteris carthusiana	Spinulose wood fern		p	p	p		p		p				p	p			p		p	
Dryopteris cristata	Crested wood fern	p	p		p	p	p	p			p	p	p	p	p		p		p	
Dryopteris intermedia	Evergreen Wood Fern						p							p						
Dulichium arundinaceum	Dulichium	p						p		p										
Eleocharis acicularis	Spike rush										p									

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Species		Wetland Identification Number (note: Wetland #5 has been infilled) p=present																		
Binomial	**Common Name**	1	2	3	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Eleocharis obtusa	Spike rush	p	p							p	p	p		p						
Eleocharis palustris	Spike rush										p									
Elymus repens	Couch grass										p									
Epilobium angustifolium	Fireweed												p							
Epilobium ciliatum	Willowherb		p	p		p	p					p	p	p			p		p	
Epilobium leptophyllum	Willow-herb	p		p	p	p		p	p	p		p	p			p			p	
Epilobium palustre	Willow-herb																	p		
Equisetum arvense	Field horsetail	p																	p	
Equisetum fluviatile	Water horsetail									p										
Equisetum sylvaticum	Wood horsetail		p								p	p	p		p	p	p	p	p	
Eriophorum virginicum	Cotton-grass			p							p					p	p	p		
Eupatorium maculatum	Joe-pye-weed	p	p			p	p		p	p		p	p	p	p				p	
Eupatorium perfoliatum	Boneset			p	p							p		p				p		
Euthamia graminifolia	Narrow-leaved goldenrod	p			p	p			p				p	p	p					
Fragaria virginiana	Wild strawberry								p			p		p						
Galium asprellum	Rough bedstraw	p	p	p							p	p	p							
Galium palustre	Marsh bedstraw				p	p	p			p	p	p		p	p		p			
Galium tinctorium	Small bedstraw		p							p									p	
Gaultheria hispidula	Snowberry										p	p				p		p		
Gaultheria procumbens	Teaberry															p		p		
Geum aleppicum	Avens											p								
Geum macrophyllum	Avens											p								
Geum sp.	Avens					p														
Glyceria borealis	Northern manna-grass		p							p										
Glyceria canadensis var. laxa	Rattlesnake grass	p		p	p	p	p		p	p	p			p	p	p	p	p		
Glyceria grandis	Reed manna-grass		p			p	p		p	p		p	p	p						
Glyceria striata var. stricta	Fowl manna-grass	p	p		p	p	p	p				p	p	p	p				p	
Gymnocarpium dryopteris	Oak fern												p							
Hieracium caespitosum	Hawkweed													p						
Hydrocotyle americana	Water-pennywort		p									p	p							
Hypericum canadense	St. john's-wort																	p		
Hypericum ellipticum	St. John's-wort	p																		
Hypericum mutilum	St. John's-wort										p	p		p						
Impatiens capensis	Spotted touch-me-not	p	p	p		p	p		p	p	p	p	p	p					p	
Iris versicolor	Blue-flag	p	p	p	p	p	p	p	p	p	p			p		p	p			p
Juncus brevicaudatus	Rush	p	p							p	p	p		p				p		
Juncus canadensis	Rush	p		p	p			p		p	p	p								

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Juncus effusus	Soft rush	p		p	p	p		p	p	p	p	p		p	p	p				
Juncus filiformis	Rush	p																		
Juncus pelocarpus	Rush	p																		
Lactuca canadensis	Wild lettuce												p	p						
Leersia oryzoides	Rice cut-grass	p	p							p	p			p						
Lemna minor	Lesser duckweed	p				p														
Linnaea borealis	Twin-flower							p			p	p								
Ludwigia palustris	False loosestrife					p	p			p				p						
Luzula acuminata	Woodrush												p							
Lycopus americanus	Water-horehound	p				p			p		p	p	p							
Lycopus uniflorus	Bugle weed	p	p	p	p		p	p	p	p	p	p	p	p	p		p	p	p	p
Lysimachia ciliata	Fringed loosestrife								p		p	p								
Lysimachia terrestris	Yellow candle	p	p	p		p	p	p	p	p	p			p						
Lysimachia thyrsiflora	Water Loosestrife	p																		
Lythrum salicaria	Purple Loosestrife					p				p										
Maianthemum canadense	Wild lily-of-the valley	p			p	p		p			p	p			p		p		p	p
Mentha arvensis	Field-mint		p							p		p	p							
Mitella nuda	Miterwort												p							
Monotropa uniflora	Indian pipe										p					p	p	p		
Myosotis laxa	Small forget-me-not	p	p			p				p	p	p	p	p					p	
Nuphar variegatum	Cow-lily										p									
Oenothera parviflora	Small-flowered evening-primrose										p									
Onoclea sensibilis	Sensitive fern	p	p	p		p	p		p	p		p	p	p	p		p		p	
Osmunda cinnamomea	Cinnamon fern	p	p	p	p		p					p	p			p	p	p	p	
Osmunda claytoniana	Interrupted fern		p			p											p		p	
Osmunda regalis	Royal fern	p			p	p										p	p			
Oxalis stricta	Yellow wood-sorrel											p								
Panicum boreale	Panic grass										p	p								
Phegopteris connectilis	Northern beech fern		p										p							
Platanthera clavellata	Fringed orchid			p							p					p	p		p	
Platanthera dilatata	White bog-orchid														p					
Platanthera grandiflora	Large purple fringed orchid														p		p			
Platanthera psycodes	Purple fringed orchid		p			p					p	p							p	
Poa palustris	Meadow-grass						p		p				p	p	p					
Poa pratensis	Kentucky bluegrass												p	p						
Polygonum amphibium	Water Smartweed	p																		
Polygonum hydropiper	Water-pepper											p	p							

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Polygonum hydropiperoides	Mild Water-pepper													p						
Polygonum punctatum	Water-smartweed					p														
Polygonum robustius	Knotweed		p			p				p										
Polygonum sagittatum	Tear-thumb	p	p	p	p	p	p		p	p	p	p	p	p	p				p	p
Polygonum sp.	Knotweed		p								p									
Potamogeton epihydrus	Pondweed										p									
Potamogeton foliosus	Leafy Pondweed	p																		
Potamogeton sp.	Pondweed										p									
Potentilla palustris	Marsh cinquefoil	p	p																	
Potentilla simplex	Cinquefoil								p		p									
Prenanthes trifoliolata	Gall-of-the-earth		p									p	p					p	p	
Proserpinaca palustris	Mermaid-weed	p								p										
Prunella vulgaris	Heal-all		p										p							
Ranunculus acris	Tall buttercup					p														
Ranunculus aquatilis	White Water-crowfoot										p									
Ranunculus repens	Creeping buttercup	p	p						p				p	p						
Rhyncospora alba	Beak rush	p																		
Rubus pubescens	Dewberry	p	p			p	p	p			p	p	p	p	p				p	
Rumex crispus	Curled dock	p																		
Rumex orbiculatus	Water-dock									p										
Scirpus atrovirens	Bulrush																	p		
Scirpus cyperinus	Bulrush	p	p	p		p		p	p	p		p	p	p	p			p	p	
Scirpus microcarpus	Bulrush	p			p				p					p						
Scirpus validus	Bulrush		p																	
Scutellaria galericulata	Skullcap	p										p								
Scutellaria lateriflora	Skullcap					p	p			p	p		p	p					p	p
Senecio aureus	Golden Ragwort										p	p	p							
Senecio jacobaea	Stinking willy												p							
Sium suave	Water-parsnip	p					p		p	p	p									
Smilacina trifolia	Three-leaved false solomon's seal			p										p		p	p	p	p	p
Solanum dulcamara	Bittersweet	p	p	p		p	p			p	p									
Solidago canadensis	Canada goldenrod	p							p			p		p					p	
Solidago gigantea	Goldenrod	p	p			p		p		p	p	p	p		p				p	
Solidago rugosa	Rough goldenrod	p	p	p		p	p				p		p	p	p			p	p	p
Solidago uliginosa	Bog-goldenrod			p	p			p	p		p	p			p		p	p	p	
Sonchus arvensis	Perennial sow-thistle	p											p							
Sonchus arvensis	Perennial Sow-thistle													p						

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Species		Wetland Identification Number (note: Wetland #5 has been infilled) p=present																		
Binomial	**Common Name**	1	2	3	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Sparganium americanum	Bur-reed	p								p	p									
Sparganium angustifolium	Bur-reed										p									
Sparganium emersum	Bur-reed		p		p					p	p									
Sparganium sp.	Bur-reed	p								p										
Spartina pectinata	Broad-leaf	p																		
Spirodela polyrhyza	Duckweed	p								p										
Stellaria borealis	Northern starwort								p											
Taraxacum officinale	Dandelion			p																
Thalictrum pubescens	Meadow-rue	p				p					p	p								
Thelypteris noveboracensis	New york fern										p									
Thelypteris palustris	Marsh fern	p	p		p	p				p	p	p	p				p			
Triadenum fraserii	Marsh St. John's-wort	p	p	p	p		p	p	p	p	p				p	p	p			
Trientalis borealis	Star flower				p												p		p	p
Tussilago farfara	Coltsfoot					p						p								
Typha angustifolia	Narrow-leaved cat-tail											p								
Typha latifolia	Broad-leaved cat-tail	p	p			p		p		p	p	p	p					p	p	
Veronica scutellata	Marsh-speedwell	p									p			p						
Vicia cracca	Tufted vetch	p																		
Vicia dasycarpa	Vetch												p							
Viola cucullata	Blue violet	p	p		p		p		p			p		p	p			p		
Viola macloskeyi	Small white violet	p			p		p	p		p	p							p		

3.0 North American Wetland Conservation Council Wetland Evaluations

Growing evidence clearly demonstrates the very important role that wetlands play in our total environment. The Wetland Evaluation Guide (Bond *et al.* 1992) has been developed to assist planners, municipal administrators, politicians, developers and landowners to make informed land use decisions concerning wetland resources. The Guide provides a tiered, step-by-step evaluation process, moving from basic to more sophisticated analysis, and from known documented and recognized values to more specific values which must be researched in detail for the particular wetland under review. The evaluator could be a planner, administrator, politician or wetland conversion proponent/opponent or a specialist whom they have retained. The evaluator moves from Stage One to Stage Two and finally Stage Three only if the preceding stage is unable to clearly establish a suitable land use preference. In most situations, not all stages will have to be applied. This permits efficient use of resources and time to inventory only the factors which must be addressed to reach a decision.

Land use decisions affecting wetlands have frequently been based primarily on the economic worth of the proposed land use activity. While economic worth is important, other costs or impacts of such activity, for example the loss of wetland functions and their value to society, are often not properly identified. The Guide provides the basis for a comparison of the full range of wetland values.

To apply the Guide it is necessary to proceed sequentially through each step. The evaluation should be undertaken only if the proposed land use or project development may directly or indirectly affect a wetland or wetland system. While many small projects (*e.g.*, agricultural drainage) may not appear to be significant, their effect on a wetland or wetland complex may be as important as large development projects. All projects with potential impacts on wetlands should be screened.

3.1 Wetland 1

3.1.1 Process

3.1.1.1 Background

Name Jacques Whitford Environment Limited

Address 3 Spectacle Lake Drive, Dartmouth, Nova Scotia B3B 1W8

Date December 20, 2002

3.1.1.2 Project

This section describes the proposed project. It is essential that the project be described before proceeding with this section.

a. **Summary of Project** (fill in and check the boxes)

Name of Project Construction of Highway 104 Antigonish

i.	Is it a public or private project?	☒ Public ☐ Private	
ii.	Does it require land use approval?	☐ Yes	☒ No
iii.	Where is it located? Antigonish, Antigonish County, Nova Scotia		
iv.	Is it proposed in or near a wetland?	☒ In	☐ Near
v.	Will the wetland be fully or partially drained?	☐ Fully	☐ Partially
	fully or partially dredged?	☐ Fully	☐ Partially
	completely or partially filled?	☐ Completely	☒ Partially
	fully or partially dyked?	☐ Fully	☐ Partially (Temporarily)
	fully or partially flooded?	☐ Fully	☐ Partially
	fully or partially enhanced/restored?	☐ Fully	☐ Partially
	Other		

b. **Type of Activity Proposed** (check appropriate boxes; if necessary describe under "other")

i. ☐ Industrial
ii. ☐ Commercial
iii. ☐ Residential
iv. ☐ Institutional
v. ☐ Recreational/Tourism
vi. ☐ Agriculture
vii. ☒ Transportation/Utility Corridor
viii. ☐ Habitat Development
ix. ☐ Forestry
x. ☐ Other (describe)
xi. Statement of Project Purpose To upgrade the highway near Antigonish to current standards for 100 series highway.
xii. Precise Description of Activity Construction of 15 km of twinned 100 series highway.

c. **Status of Project** (land use controls which might affect the project)

i. **Jurisdiction of Approving Authority**

☒ Federal
☒ Territorial/Provincial
☐ Municipal/Regional
☐ Native

ii. **Type of Mandatory Review**

Mandatory review required?
☒ Yes ☐ No

Environmental Impact Assessment required?

☒ Yes	☐ No	Federal
☒ Yes	☐ No	Territorial/Provincial
☐ Yes	☒ No	Municipal
☐ Yes	☒ No	Native

iii. **Does the project fall under Municipal Development Control?** (If yes continue, if no go to "iv")

Type of Control:
☐ Approved Development Plan
☐ Approved Zoning By-Law
☐ Approved Environmental Impact Assessment (EIA)
☐ Approved Performance Standards
☐ Other (described) ____________________

iv. **Status of Proposal**

☐ Not Submitted
☒ Under Review
☐ Approved
☐ Denied
☐ Under Appeal
☐ Requires Zoning

v. **Sources of Funding** (check one or more)

☐ Private Financing
☒ Public Financing
☐ Public Subsidy
If public subsidy, please name program ____________________

vi. **Level of Project Understanding/Refinement** (check one)

☐ At very preliminary stage; little or no economic cost/benefit analysis
☒ Preliminary stage; conceptual drawings, economic cost/benefit analysis, environmental impact considerations
☐ Detailed design; design drawings, cost/benefit analysis (all components), and Environmental Impact Assessment

vii. **Potential for Stewardship**

Stewardship represents landowner commitment to manage the wetland in society's interest. Does that potential exist for this wetland?
☐ Yes
☒ No
☐ Maybe
If yes or maybe, what steps are needed to institute a stewardship program? ____________________

d. **Project Production Summary**

This section examines the products (i.e. benefits and disbenefits) which the project might generate.

i. **Has an economic analysis been completed for the project?**

☒ Yes (continue to "ii")
☐ No (go to "iv")

If yes, by whom:
☐ by proponent in-house
☒ by professional consultant
☒ other (name/agency/organization) Louis Berger (Canada) Ltd. commissioned by the Atlantic Expressway Committee; Beasy Nicoll Engineering Ltd. commissioned by NSTPW

Information about analyst

Name Louis Berger (Canada) Ltd. / Beasy Nicoll Engineering Ltd.
Address Unknown /80 Eileen Stubbs Avenue Dartmouth NS
Telephone No. Unknown / 902-468-4740
Date Analysis Prepared June 1996/ January 1999

ii. **Status of Economic Findings** (evaluator's opinion only)

☐ Detailed, thorough economic findings
☒ Preliminary economic findings
☐ No economic findings (go to "iv")
☐ Information not available (g to "iv")

iii. **Summary of Findings/Project Benefits** (if no estimates, check box; if estimates are available indicate information on line provided)

☒ Permanent jobs (person/years)
☒ Permanent contribution to new area wages per year
☒ Permanent contribution to new area spending (total per year)
☐ Construction jobs (person/years) 167
☐ Construction contribution to new area wages per year $2 million
☐ Construction contribution to area spending (total per year) $74 million
☒ Increased production by type (e.g. agriculture, forestry, tourism)
☒ Other benefits
☒ Amenity Contribution

iv. **Summary of Potential Disbenefits** (check the appropriate boxes)

There are expected problems that may occur because of the project. These potential problems are the preliminary issues that will need to be addressed as part of the project review.

☒ Noise
☐ Air pollution
☒ Water pollution
☐ Water drawdown
☒ Habitat loss
☐ Aesthetic loss
☐ Recreational loss
☐ Economic loss
☐ Other

e. **Summary of Expected Level of Selected Project Impacts** (check box for high, moderate, or low)
The following table provides project information which will assist in subsequent considerations of potential project impact upon the wetland under review. This table summarizes the evaluator's views based upon existing known information.

POTENTIAL WETLAND IMPACTS	**LEVEL OF EXPECTED IMPACT** HIGH	 MODERATE	 LOW
Noise Pollution		✓	
Air Pollution			✓
Water Pollution			✓
Water Drawdown			✓
Habitat Loss			✓
Aesthetic Loss			✓
Recreational Loss			✓
Other			

POTENTIAL ECONOMIC IMPACTS	**LEVEL OF EXPECTED IMPACT** HIGH	 MODERATE	 LOW
Employment			✓
Training			✓
Construction Spending		✓	
Operation Spending			✓
Taxes			✓
Indirect Spending*			✓
Flood Protection			✓
Other			✓

* (e.g. Tourism)

f. **Project Summary** (project description, sources, and a summary of findings that may be useful in future analysis)

A project description and analysis of environmental effects is presented in the "Highway 104 Antigonish Environmental Assessment Report" prepared for Nova Scotia Department of Transportation & Public Works by Jacques Whitford Environment Limited

3.1.1.3 Wetland Description

This section describes the affected wetland. It is essential that the wetland be described before proceeding.

a. **Wetland Location**

Province/Territory Nova Scotia
Common Place Name (if any) Antigonish
Nearest Urban Centre Antigonish
Legal Description (if any) None

Land Description: ☐ Public
☒ Private
☐ Protected Area
☐ Other
If public, name of area/site (if any)

If protected, name of agency and status

b. **Map**

Show location of wetland and proposed project in relation to region. (Draw or place map here, or attach map and/or project plan to back of this page. Indicate direction of north and ensure that map contains a scale).

(See Figure 5.4).

c. **Wetland Context**

This provides a brief description of the wetland and preliminary relationship to the project.

i. **Wetland Complexity**

			Size
Is this a single wetland	☐ Yes	☒ No	ha ( ) acres
Is this a wetland complex*	☒ Yes	☐ No	11.2 ha ( ) acres

(**i.e.* a series of more than one wetland)

ii. **Wetland Class**

a) **Single Wetland** (Check one only)	b) **Wetland Complex** (Check all classes present, and write number if it occurs more than once)	c) **Wetland Classification**
☐ Bog	☐ Bog	☐ Temporary
☐ Fen	☐ Fen	☐ Seasonal
☐ Swamp	☒ Swamp Four types	☒ Permanent
☐ Marsh	☒ Marsh Two types	
☐ Shallow Water	☒ Shallow Water	

iii. **Has this wetland been previously impacted?**

☒ Yes ☐ No

If yes, describe A small portion of the wetland was infilled during construction of Highway 104

Additional Comments Regarding Wetland Description

See Table 11 for a description of the wetland.

3.1.2 Preliminary Screening

This section examines two key considerations prior to the application of the three evaluation stages. These considerations relate to:
1. Potential for project relocations
2. Project redesign
3. Wetland viability

3.1.2.1 Potential for Project Relocation

This section examines the possibility of relocating the project away from the wetland, in order to reduce potential direct or indirect effects that may occur. It should be completed in association with the proponent. **(The proponent should be made aware of the subsequent evaluations procedure which may be necessary if relocation is not undertaken or is not possible).**

a. **How important is the wetland site for this project?**
☐ Essential (go to 3.1.2.2)
☒ Important (go to 3.1.2.2)
☐ Desirable (go to 3.1.2.2)
☐ Unnecessary (go to "b")
☐ Unknown (go to 3.1.2.2)

b. **Is an alternative location available?**
☐ Yes Where? (go to "c")
☐ No (go to 3.1.2.2)

c. **Does an alternative locations create detrimental impacts to other uses?**
☐ Yes (go to 3.1.2.2)
☐ No (go to "d")

d. **What is the rationale for relocation of the project, or why must it be located on this wetland site?**

____

e. **Project recommended for relocation?**
☐ Yes (go to "f")
☐ No (go to 3.1.2.2)

f. **Is proponent prepared to relocate?**
☐ Yes (if alternative location recommended and proponent accepts evaluation, stop here)
☐ No (go to 3.1.2.2)

____________________________ ________________________
Evaluator's Signature **Date**

CONCLUSION OF ALTERNATIVE PROJECT SITE CONSIDERATION

3.1.2.2 Project Redesign

A proposed project may require a simple or difficult redesign or change in project management practices to minimize wetland effects. This section examines that opportunity. You may need to reconsider this section after the Stage One and Stage Two evaluations.

a. **Is project redesign possible?**
☐ Very likely (go to b)
☐ Possibly (go to b)
☒ Not Possible (go to f)

b. **Will the redesign significantly reduce the impact to the wetland?**
☐ Yes (go to c)
☐ No (go to f)

c. **If the project can be redesigned, will a redesign require other conditions?**
☐ Yes (go to d)
☐ No (go to f)

d. **What are the conditions for redesign?**
☐ Rezoning of other land
☐ Subsidies
☐ Other (specify) ____________________

e. **Are these conditions achievable?**
☐ Very likely (go to j)
☐ Possibly (go to j)
☐ Not Possible (go to 3.1.2.3)
If not possible, why? ____________________

f. **Are changes in the way the project is managed possible?**
(e.g. landscaping, cultivation practices, design of infrastructure)
☐ Very likely (go to g)
☒ Possibly (go to g)
☐ Not Possible (go to 3.1.2.3)

g. **Will changes in the way the project is managed significantly reduce impact to the wetland?**
☐ Yes (go to h)
☒ No (go to 3.1.2.3)

h. **What are the conditions for a change in the way the project is managed?**
☐ Subsidies
☐ Alteration to regulations
☐ Other (specify) ____________________

i. **Are these conditions achievable?**
☐ Very likely (go to j)
☐ Possibly (go to j)
☐ Not Possible (go to 3.1.2.3)
If not possible, why? ____________________

j. **Interim Recommendations**
- ☐ The project should be redesigned; or
- ☐ The way the project is managed should be modified; or
- ☐ The proponent and approving authority will proceed to modify the project to protect the wetland.
- ☐ The evaluation should proceed.

The evaluator should consider such redesign or management practices in association with the proponent and/or the approving authority. Once discussions have been held, the evaluator should proceed to complete "k".

k. **Record of Action**
- ☐ Project satisfactorily redesigned; or
- ☐ Project management practices satisfactorily modified; or
- ☒ Proceed to Section 3.1.2.3

Additional Comments Regarding Project Redesign Considerations

None

CONCLUSION OF PROJECT REDESIGN CONSIDERATION

3.1.2.3 Wetland Viability

Wetland viability is the key consideration in the process of wetland and proposed project evaluation. A wetland, which has been severely and detrimentally affected over time and cannot be reasonably rehabilitated, should be considered for detailed analysis in Stage Two, only if it represents one of the last such wetland types in the region. Otherwise, a wetland that has been impacted previously beyond critical thresholds of viability should not be considered further and the project should be recommended for development.

Preliminary Screening: Cumulative Impact

This section provides an evaluation of the status of the wetland in a temporal and spatial context. It indicates the degree to which the wetland has been impacted previously by direct or indirect human induced activities and the degree to which the wetland will likely continue to deteriorate with and without the cumulative effects of the proposed project.

a. **Results of Past Effects upon the Wetland**

Has the wetland decreased in size during the past five years?

☐ Yes
☒ No
☐ Don't know (go to 3.1.3.0)
If yes, by how much: ☐ Highly affected
☐ Moderately affected
☐ Minimally affected

Is the wetland known to be detrimentally affected by other nearby projects or drainage system changes?

☐ Yes
☒ No
☐ Don't know (go to 3.1.3.0)
If yes, by how much: ☐ Highly affected
☐ Moderately affected
☐ Minimally affected

Have animal or plant communities been detrimentally impacted by past activity?

☒ Yes
☐ No
☐ Don't know (go to 3.1.3.0)
If yes, by how much: ☐ Highly affected
☐ Moderately affected
☒ Minimally affected

Have the wetland hydrological characteristics been detrimentally affected by other nearby activities?

☒ Yes
☐ No
☐ Don't know (go to 3.1.3.0)
If yes, by how much: ☐ Highly affected
☐ Moderately affected
☒ Minimally affected

b. **Potential Rehabilitation/Restoration**

Can the wetland be rehabilitated/restored?
☒ Likely
☐ Unlikely
☐ Very Unlikely

At what cost?
☐ Very Costly
☐ Costly
☒ Not Very Costly

c. **Wetland Status**

This item relates to the degree to which the cumulative impacts have passed an acceptable threshold level, and the wetland is beyond restorative assistance. Wetlands that are considered "lost" do not warrant further consideration unless they represent one of the last wetlands of their type in the region.

Has the wetland been compromised up to or beyond its viability as a functioning wetland?
☐ Yes (if yes, then complete next question"
☒ No (if no, go to Stage One (see Section 3.1.3.0).

Have most similar wetland types been lost to conversion in the region?
☐ Yes (if yes, go to "d. Recommendation" and consider (1) and (2)
☒ No (if no, go to "d. Recommendation" and consider (3) and (4)

d. **Recommendation**
☐ (1) Protect wetland as a representative or unique example.
☐ (2) Consider restoration/rehabilitation of wetland.
☐ (3) Consider proceeding with development if cumulative impact on wetlands are already high.
☒ (4) Proceed to Section 3.1.3.0, Stage One.

If recommendation 1, 2, or 3 accepted, stop evaluation here.

Evaluator's Signature

Date

Name of Wetland Wetland 1	Antigonish, Nova Scotia
Name	*Area/Town/Province/Territory*

Complete this evaluation in a sequential manner.

3.1.3 Stage One "General Analysis"

The "General Analysis" is designed to provide land use planners, administrators, developers, and the public with an opportunity to examine the relative value of wetlands, and any proposed projects which may directly or indirectly impact those wetland values. This "General Analysis" sets out a process of easily identifying - from readily available public data - biological, hydrological and biogeochemical, social/cultural, and production wetland functions and the expected new production functions generated by the proposed project. All considerations are at an international, national, or provincial level of significance. A few are also at a regional scale of consideration.

Comparing the importance of the wetland and the project, provides the evaluator with knowledge about the desirability of : (1) protecting the wetland because it has outstanding value; (2) approving the project because it has outstanding value and the wetland has little or no value; and (3) deferring to Stage Two because no conclusion is obvious. The ratings provide guidance only to the recommendations.

Note: When listing sources, indicate relevant documents, authorities, and agencies.

Stage One Evaluation undertaken by:
Name Jacques Whitford Environment Limited
Address 3 Spectacle Lake Drive, Dartmouth, Nova Scotia B3B 1W8

Stage One values are based upon obvious, easily verified findings. Lack of sufficient information or inconclusive results will trigger the Stage Two applications. Values allocated are:

H = High value (3); M = Moderate Value (2); L = Low Value (1); NA= Not Applicable (X)

Where information is not available or unknown, check additional sources. If still unavailable or unknown, then automatically proceed to Stage Two Detailed Analysis.

3.1.3.1 Biological Component: Importance to Wildlife/Plant Communities

Potential Source of Data:
- Territorial/Provincial Wildlife or Natural Resources Agency
- University/Community College, Botany and Biology Departments
- Canadian Wildlife Service/Wildlife Habitat Canada office
- Local Ducks Unlimited Canada office
- Canada Land Inventory (Agriculture and Agri-Food Canada)

i. **Significance for Waterfowl/Wildlife Species**
This relates to the importance, at a national or provincial scale of significance, of the wetland as a habitat for the production, migration, or other life history events for waterfowl and other animal species at a national or provincial scale of significance. (Select most current classification, and shade numbers in either the Canada Land Inventory box OR the Provincial/Territorial Classification box. Enter shaded numbers on the lines beside each column and their sum on the subtotal line).

Canada Land Inventory	High (Class 1-2)	Moderate (Class 3-4)	Low (Class 5-7)	Not Available	
Waterfowl	3	2	1	X	
Wildlife	3	2	1	X	

Subtotal (maximum is 6)
(Where "x" occurs, go to "Stage Two Detailed Analysis").

or

Provincial/Territorial Classification	High	Moderate	Low	Not Available	
Waterfowl	3	2	1	X	1
Wildlife	3	2	1	X	1

Subtotal (maximum is 6)
(Where "x" occurs, go to "Stage Two Detailed Analysis"). 2

Source Wetland Atlas - Wetland Protection Mapping (Canadian Wildlife Services 1984)
Wetland Survey Conducted in the Wetland (2002)

ii. **Rarity/Scarcity or Uniqueness**

This relates to the degree to which the wildlife and vegetation species and populations inhabiting the wetland are rare, endangered or vulnerable within the region. (shade numbers and total them).

	High	Moderate	Low	Not Available	
Waterfowl/Wildlife	3	2	1	X	1
Vegetation	3	2	1	X	2

Subtotal (maximum is 6) 3
(Where "x" occurs, go to Stage Two Detailed Analysis).

Source Andrew Hebda, Curator of Zoology, Nova Scotia Museum of Natural History
Marian Munroe, Curator of Botany, Nova Scotia Museum of Natural History
Atlas of Rare, Threatened and Infrequent Fauna of Nova Scotia (Fuller 1998, internal document)
Atlas of Rare Vascular Plants in Nova Scotia (Pronych and Wilson 1993)
Atlas of Breeding Birds of the Maritime Provinces (Erskine 1992)
The Amphibians and Reptiles of Nova Scotia (Gilhen 1984)
Atlantic Canada Conservation Data Centre data request and general status ranks for vascular plants, birds, mammals, reptiles and amphibians.
Nova Scotia Department of Natural Resources General Status Ranks of Wild Species in Nova Scotia (Vascular plants, birds, mammals, reptiles and amphibians).
Vegetation and wildlife surveys conducted within wetland.

Total Biological Component Rating: 5

(Maximum is 12)
(Add "i" + "ii" subtotal, transfer total to equation in "3.1.3.6).

3.1.3.2 Hydrological Component: Water Quality/Groundwater/Erosion Control/Flood Control

This relates to the importance of the wetland for valued hydrological functions. It may be a general rating based on interviews with water analysts.

Source of Data: • Territorial/Provincial/Federal Water Resources Agencies
(shade numbers and total them)

	High	Moderate	Low	Not Available	
Significance of Contribution to Provincial Regional Water Quality/Groundwater	3	2	1	X	1
Significance of Contribution to Provincial/Regional Erosion Control/Flood Control	3	2	1	X	2

Total Hydrological Rating (maximum is 6) 3
(transfer total to "3.3.3.6")

Source Wetland Survey and consultation with hydrologist (Hans Arisz, Hydrocom Technologies Ltd.).

3.1.3.3 Social/Cultural Component: Contribution to Quality of Life

This relates to the existing public commitment to the wetland as exemplified by way of current legislated actions that protect significant wetland resources.

Sources of Data:
- Territorial/Provincial Lands Branch
- Territorial/Provincial Planning Branch
- Territorial/Provincial Environment Branch

(shade numbers and total them)

	High	Moderate	Low	
Existing, Proposed or Potential International/National/Provincial/Regional Heritage Designation or Protected Status (within or adjacent to the protected area).	3	2	1	1

Total Social/Cultural Rating (maximum is 3) 1
(transfer total to 3.1.3.6)

Source Atlantic Canada Conservation Data Centre
Beardmore (1985)
Mark Pulsifer, Nova Scotia Department of Natural Resources
Rachel Gautreau, Canadian Wildlife Service

3.1.3.4 Production Component: Expected New Project Benefits

This relates to the potential new added value production benefits which may result from implementation of the project, both geographically and within the economic sectors.

Sources of Data:
- The proponent
- Territorial/Provincial Economic Development Agency
- Municipal/Regional Economic Development Office

(shade number and total them)

	High	Moderate	Low	
Significance of Project to the Economic Sector (e.g. agriculture, forestry, or tourism)	3	2	1	3
Economic Significance to National, Provincial, Regional Development and Employment	3	2	1	3

Total Production Component Rating (maximum is 6) 4
(transfer total to 3.1.3.6)

Source Loius Berger (Canada) Ltd. (1996)
Beasy Nicoll Engineering Ltd. (1999)

3.1.3.5 Copy of All Relevant Findings and Sources Attached

☐ Yes
☒ No

If no, then list

Information collected during the wetland survey are presented in Tables I1 and I2. A list of sources of existing data used in the evaluation is presented below.

Beasy Nicoll Engineering Limited. 1999. Highway 104 Antigonish Safety Review. Dartmouth, NS

Bond, W.K., K.W. Cox, T. Heberlein, E.W. Manning, D.R. Witty, and D.A. Young. 1992. Wetland Evaluation Guide. North American Wetlands Conservation Council (Canada), Issues Paper, No. 1992-1

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002. Canadian Species at Risk

Erskine, A.J. 1992. Atlas of Breeding Birds of the Maritime Provinces. Nimbus Publishing and the Nova Scotia Museum, Halifax, NS

Fuller, S. 1998. Atlas of Rare, Threatened and Infrequent Fauna of Nova Scotia. Nova Scotia Museum of Natural History draft internal document, Halifax, N.S.

Gilhen, J. 1984. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum, Halifax, NS

Louis Berger (Canada) Ltd. 1996. An Assessment of the Economic Impact of Upgrading the Trans Canada Highway 104 To a Four-Lane, Divided, Controlled Access Highway Through Antigonish County. Atlantic Expressway Committee, Antigonish, NS.

NSDNR (Nova Scotia Department of Natural Resources). 2002a. General Status Ranks of Wild Species in Nova Scotia. Internet Publication: http://www.gov.ns.ca/natr/wildlife/genstatus/specieslist.asp.

NSDNR (Nova Scotia Department of Natural Resources). 2002b. Species at Risk in Nova Scotia. Internet Publication: http://www.gov.ns.ca/natr/wildlife/endngrd/specieslist.htm.

Pronych and Wilson, 1993. Atlas of Rare Vascular Plants in Nova Scotia. Curatorial Report No.78. Nova Scotia Museum of Natural History, Halifax, N.S.

ACCDC (Atlantic Canada Conservation Data Centre). 2002. Species Lists and Rare Species. Internet Publication: http://www.accdc.com/info/lists/.

Scott, F.W. 1994. Provisional Annotated List of Plant and Animal Species Considered to be Rare in Nova Scotia. Nova Scotia Museum of Natural History. Halifax, NS

Describe other major issues relevant to a decision As discussed in the Highway 104 Antigonish Environmental Assessment Report (Sections 2.1 and 6.4), the upgrade of the Highway is necessary due to increasing traffic volumes and concerns for public safety. The Five Year (1996 to 2000) blended or combined PDO collision rates for the 12.1 km of highway within the study area are about 40% higher than the comparable five year average for all provincial 100 series highways without access control. A detailed route selection process was undertaken by NSTPW to evaluate a number of options and select one alignment based on consideration of safety, and environmental and socio-economic constraints. The selected alignment is based on this evaluation and proposes to minimize disturbance where possible; however it will impinge upon some wetlands that are unavoidable due to pre-existing development or further environmental constraints.

3.1.3.6 Overall Project Impact Rating

An overall project rating occurs when the preceding Sections (3.1.3.1 - 3.1.3.4) are examined to compare the overall significance of the wetland to that of the proposed project. This significance is identified in the rating calculation which follows.

a. **Rating Calculation**
(insert total from previous Sections (3.1.3.1 - 3.1.3.4) in boxes provided, subtract total in Section 3.1.3.4. from total of 3.1.3.4 to 3.1.3.3 and calculate overall ratings)

Current Wetland Status

3.1.3.1 Biological Rating	5	(a)
3.1.3.2 Hydrological Rating	3	(b)
3.1.3.3 Social/Cultural Rating	1	(c)

Project Status

3.1.3.4 Projected Production Change Rate	4	(d)

Overall Rating=
a+b+c minus d = e 5

Note: When a value of "U" (unknown) or "NA" (not available) occurs, then proceed to either gather that information or move directly to Stage Two Detailed Analysis to address that requirement.

b. **Overall Rating**

The equation totals the three wetland function component values (a+b+c) and subtracts the new project production benefits value (d). The result is an overall rating (e) which represents the value of the wetland in relation to the benefits of the proposed project.

- Maximum possible value: 19
- Minimum possible value: 1
- Where overall rating is equal to or greater than 13, project rejection (or relocation) should be recommended.
- Where overall rating is equal to or less than 3, project approval should be recommended.
- Where overall rating is between 4 and 12 inclusive, project should be referred to Stage Two Detailed Analysis.

Recommendations

- ☐ (a) reject project
- ☐ (b) refer to Stage Two Detailed Analysis
- ☐ (c) approve without conditions
- ☒ (d) approve with conditions

(List necessary mitigative measures and measures to retain/enhance wetland functions of value to society in (e))

(e) mitigative measures 1) Construct wetland habitat along the edge of Wetland 1 to replace the 0.35 ha of habitat lost at this wetland. 2) Salvage wetland soils from disturbed portion of wetland to aid in rapid re-establishment of native plant communities in reconstructed wetland. 3) Test salvaged wetland soil to ensure that it will not release stored contaminants 4) Ensure that the hydrology of the wetland is maintained through proper culvert placement. 2) Implement erosion and sediment control measures to minimize sedimentation of wetland.

(f) reason for recommendation (note: outline by project benefits and important wetland functions/values lost or reduced do not simply report the number calculated)

The project will provide economic benefits to the local area as a result of construction activity and will improve public safety. The wetland survey and a review of the existing literature indicates that the wetland has relatively little value as wildlife habitat and as habitat for rare or endangered species. Two uncommon plant species, water loosestrife (*Lysimachia thyrsiflora*) and marsh mermaid-weed (*Proserpinaca palustris*), are present in the wetland. The populations of both of these species are considered secure in Nova Scotia. Infilling during road construction may result in the loss of a very small portion of the population of marsh mermaid-weed which is one of the dominant species of the marsh habitat in the wetland. Water loosestrife will not be affected by construction. The wetland has no known social/cultural attributes. The wetland plays a moderate role in surface water flow regulation. The wetland can be expected to augment surface water flow in Brierly Brook during low flow periods. The wetland probably also contributes to amelioration of flood events by slowing the flow of water through the wetland. The surface water flow regulation function is not expected to be significantly altered since only approximately 3.1 % of the total area of wetland habitat will be infilled during construction.

Evaluator's Signature **Date**

If referred to Stage Two Detailed analysis, outline particular project impacts or wetland functions/values that may be worthy of special attention.

CONCLUSION OF STAGE ONE "GENERAL ANALYSIS"

3.2 Wetland 6

3.2.1 Process

3.2.1.1 Background

Name Jacques Whitford Environment Limited

Address 3 Spectacle Lake Drive, Dartmouth, Nova Scotia B3B 1W8

Date December 23, 2002

3.2.1.2 Project

This section describes the proposed project. It is essential that the project be described before proceeding with this section.

Summary of Project (fill in and check the boxes)

Name of Project Construction of Highway 104 Antigonish

a. i. Is it a public or private project? ☒ Public ☐ Private
ii. Does it require land use approval? ☐ Yes ☒ No
iii. Where is it located? Antigonish, Antigonish County, Nova Scotia
iv. Is it proposed in or near a wetland? ☒ In ☐ Near
v. Will the wetland be fully or partially drained? ☐ Fully ☐ Partially
fully or partially dredged? ☐ Fully ☐ Partially
completely or partially filled? ☐ Completely ☒ Partially
fully or partially dyked? ☐ Fully ☐ Partially (Temporarily)
fully or partially flooded? ☐ Fully ☐ Partially
fully or partially enhanced/restored? ☐ Fully ☐ Partially
Other

b. **Type of Activity Proposed** (check appropriate boxes; if necessary describe under "other")

i. ☐ Industrial
ii. ☐ Commercial
iii. ☐ Residential
iv. ☐ Institutional
v. ☐ Recreational/Tourism
vi. ☐ Agriculture
vii. ☒ Transportation/Utility Corridor
viii. ☐ Habitat Development
ix. ☐ Forestry
x. ☐ Other (describe)
xi. Statement of Project Purpose To upgrade the highway near Antigonish to current standards for 100 series highway.
xii. Precise Description of Activity Construction of 15 km of twinned 100 series highway.

c. **Status of Project** (land use controls which might affect the project)

i. **Jurisdiction of Approving Authority**
☒ Federal
☒ Territorial/Provincial
☐ Municipal/Regional
☐ Native

ii. **Type of Mandatory Review**

Mandatory review required?

☒ Yes ☐ No

Environmental Impact Assessment required?

☒ Yes ☐ No Federal
☒ Yes ☐ No Territorial/Provincial
☐ Yes ☒ No Municipal
☐ Yes ☒ No Native

iii. **Does the project fall under Municipal Development Control?** (If yes continue, if no go to "iv")

Type of Control:

☐ Approved Development Plan
☐ Approved Zoning By-Law
☐ Approved Environmental Impact Assessment (EIA)
☐ Approved Performance Standards
☐ Other (described) ______________________________

iv. **Status of Proposal**

☐ Not Submitted
☒ Under Review
☐ Approved
☐ Denied
☐ Under Appeal
☐ Requires Zoning

v. **Sources of Funding** (check one or more)

☐ Private Financing
☒ Public Financing
☐ Public Subsidy

If public subsidy, please name program ______________________________

____

vi. **Level of Project Understanding/Refinement** (check one)

☐ At very preliminary stage; little or no economic cost/benefit analysis
☒ Preliminary stage; conceptual drawings, economic cost/benefit analysis, environmental impact considerations
☐ Detailed design; design drawings, cost/benefit analysis (all components), and Environmental Impact Assessment

vii. **Potential for Stewardship**

Stewardship represents landowner commitment to manage the wetland in society's interest. Does that potential exist for this wetland?

☐ Yes
☒ No
☐ Maybe

If yes or maybe, what steps are needed to institute a stewardship program? ______________________________

____

d. **Project Production Summary**

This section examines the products (i.e. benefits and disbenefits) which the project might generate.

i. **Has an economic analysis been completed for the project?**

☒ Yes (continue to "ii")
☐ No (go to "iv")

If yes, by whom: ☐ by proponent in-house
☒ by professional consultant
☒ other (name/agency/organization) Louis Berger (Canada) Ltd. commissioned by the Atlantic Expressway Committee; Beasy Nicoll Engineering Ltd. commissioned by NSTPW

Information about analyst
Name Louis Berger (Canada) Ltd. / Beasy Nicoll Engineering Ltd.
Address Unknown /80 Eileen Stubbs Avenue Dartmouth NS
Telephone No. Unknown / 902-468-4740
Date Analysis Prepared June 1996/ January 1999

ii. **Status of Economic Findings** (evaluator's opinion only)

☒ Detailed, thorough economic findings
☐ Preliminary economic findings
☐ No economic findings (go to "iv")
☐ Information not available (g to "iv")

iii. **Summary of Findings/Project Benefits** (if no estimates, check box; if estimates are available indicate information on line provided)

☒ Permanent jobs (person/years)
☒ Permanent contribution to new area wages per year
☒ Permanent contribution to new area spending (total per year)
☐ Construction jobs (person/years) 167
☐ Construction contribution to new area wages per year $2 million
☐ Construction contribution to area spending (total per year) $74 million
☒ Increased production by type (e.g. agriculture, forestry, tourism)
☒ Other benefits
☒ Amenity Contribution

iv. **Summary of Potential Disbenefits** (check the appropriate boxes)

There are expected problems that may occur because of the project. These potential problems are the preliminary issues that will need to be addressed as part of the project review.

☒ Noise
☐ Air pollution
☒ Water pollution
☐ Water drawdown
☒ Habitat loss
☐ Aesthetic loss
☐ Recreational loss
☐ Economic loss
☒ Other Landowner Displacement

e. **Summary of Expected Level of Selected Project Impacts** (check box for high, moderate, or low)
The following table provides project information which will assist in subsequent considerations of potential project impact upon the wetland under review. This table summarizes the evaluator's views based upon existing known information.

POTENTIAL WETLAND IMPACTS	**LEVEL OF EXPECTED IMPACT** HIGH	MODERATE	LOW
Noise Pollution		✓	
Air Pollution			✓
Water Pollution			✓
Water Drawdown			✓
Habitat Loss			✓
Aesthetic Loss			✓
Recreational Loss			✓
Other			

POTENTIAL ECONOMIC IMPACTS	**LEVEL OF EXPECTED IMPACT** HIGH	MODERATE	LOW
Employment			✓
Training			
Construction Spending		✓	
Operation Spending			✓
Taxes			✓
Indirect Spending*			✓
Flood Protection			✓
Other			

* (e.g. Tourism)

f. **Project Summary** (project description, sources, and a summary of findings that may be useful in future analysis)

A project description and analysis of environmental effects is presented in the "Highway 104 Antigonish Environmental Assessment Report" prepared for Nova Scotia Department of Transportation & Public Works by Jacques Whitford Environment Limited

3.2.1.3 Wetland Description

This section describes the affected wetland. It is essential that the wetland be described before proceeding.

a. Wetland Location

Province/Territory Nova Scotia
Common Place Name (if any) Antigonish
Nearest Urban Centre Antigonish
Legal Description (if any) None

Land Description:
☐ Public
☒ Private
☐ Protected Area
☐ Other
If public, name of area/site (if any)

If protected, name of agency and status

b. **Map**
Show location of wetland and proposed project in relation to region. (Draw or place map here, or attach map and/or project plan to back of this page. Indicate direction of north and ensure that map contains a scale).

(See Figure 5.4).

c. **Wetland Context**
This provides a brief description of the wetland and preliminary relationship to the project.

i. **Wetland Complexity**

Wetland Complexity		**Size**		
Is this a single wetland	☐ Yes	☒ No	ha (	) acres
Is this a wetland complex*	☒ Yes	☐ No	4.27 ha (	) acres

(*i.e. a series of more than one wetland)

ii. **Wetland Class**

a) **Single Wetland** (Check one only)	b) **Wetland Complex** (Check all classes present, and write number if it occurs more than once)	c) **Wetland Classification**
☐ Bog	☐ Bog	☐ Temporary
☐ Fen	☐ Fen	☐ Seasonal
☐ Swamp	☒ Swamp Two types	☒ Permanent
☐ Marsh	☒ Marsh Two types	
☐ Shallow Water	☐ Shallow Water	

iii. **Has this wetland been previously impacted?**
☒ Yes ☐ No
If yes, describe The wetland has been disturbed at various times in the past. A causway was constructed across a portion of the wetland and some habitat was lost to highway construction. Recently, treed swamp habitat in the wetland was harvested for timber.

Additional Comments Regarding Wetland Description

See Table II for a description of the wetland.

3.2.2 Preliminary Screening

This section examines two key considerations prior to the application of the three evaluation stages. These considerations relate to:

1. Potential for project relocations
2. Project redesign
3. Wetland viability

3.2.2.1 Potential for Project Relocation

This section examines the possibility of relocating the project away from the wetland, in order to reduce potential direct or indirect effects that may occur. It should be completed in association with the proponent. **(The proponent should be made aware of the subsequent evaluations procedure which may be necessary if relocation is not undertaken or is not possible).**

a. **How important is the wetland site for this project?**
☐ Essential (go to 3.2.2.2)
☒ Important (go to 3.2.2.2)
☐ Desirable (go to 3.2.2.2)
☐ Unnecessary (go to" b")
☐ Unknown (go to 3.2.2.2)

b. **Is an alternative location available?**
☐ Yes Where? (go to "c")
☐ No (go to 3.2.2.2)

c. **Does an alternative locations create detrimental impacts to other uses?**
☐ Yes (go to 3.2.2.2)
☐ No (go to "d")

d. **What is the rationale for relocation of the project, or why must it be located on this wetland site?**
____

e. **Project recommended for relocation?**
☐ Yes (go to "f")
☐ No (go to 3.2.2.2)

f. **Is proponent prepared to relocate?**
☐ Yes (if alternative location recommended and proponent accepts evaluation, stop here)
☐ No (go to 3.2.2.2)

____________________________ ________________________
Evaluator's Signature **Date**

CONCLUSION OF ALTERNATIVE PROJECT SITE CONSIDERATION

3.2.2.2 Project Redesign

A proposed project may require a simple or difficult redesign or change in project management practices to minimize wetland effects. This section examines that opportunity. You may need to reconsider this section after the Stage One and Stage Two evaluations.

a. **Is project redesign possible?**
☐ Very likely (go to "b")
☐ Possibly (go to "b")
☒ Not Possible (go to "f")

b. **Will the redesign significantly reduce the impact to the wetland?**
☐ Yes (go to "c")
☐ No (go to "f")

c. **If the project can be redesigned, will a redesign require other conditions?**
☐ Yes (go to "d")
☐ No (go to "f")

d. **What are the conditions for redesign?**
☐ Rezoning of other land
☐ Subsidies
☐ Other (specify) ____________________

e. **Are these conditions achievable?**
☐ Very likely (go to "j")
☐ Possibly (go to "j")
☐ Not Possible (go to "3.2.2.3")
If not possible, why? ____________________

f. **Are changes in the way the project is managed possible?**
(e.g. landscaping, cultivation practices, design of infrastructure)
☐ Very likely (go to "g")
☒ Possibly (go to "g")
☐ Not Possible (go to "3.2.2.3")

g. **Will changes in the way the project is managed significantly reduce impact to the wetland?**
☐ Yes (go to "h")
☒ No (go to "3.2.2.3")

h. **What are the conditions for a change in the way the project is managed?**
☐ Subsidies
☐ Alteration to regulations
☐ Other (specify) ____________________

i. **Are these conditions achievable?**
☐ Very likely (go to "j")
☐ Possibly (go to "j")
☐ Not Possible (go to "3.2.2.3")
If not possible, why? ____________________

j. **Interim Recommendations**
☐ The project should be redesigned; or
☐ The way the project is managed should be modified; or
☐ The proponent and approving authority will proceed to modify the project to protect the wetland.
☐ The evaluation should proceed.

The evaluator should consider such redesign or management practices in association with the proponent and/or the approving authority. Once discussions have been held, the evaluator should proceed to complete "k".

k. **Record of Action**

☐ Project satisfactorily redesigned; or
☐ Project management practices satisfactorily modified; or
☒ Proceed to Section 3.2.2.3

CONCLUSION OF PROJECT REDESIGN CONSIDERATION

3.2.2.3 Wetland Viability

Wetland viability is the key consideration in the process of wetland and proposed project evaluation. A wetland, which has been severely and detrimentally affected over time and cannot be reasonably rehabilitated, should be considered for detailed analysis in Stage Two, only if it represents one of the last such wetland types in the region. Otherwise, a wetland that has been impacted previously beyond critical thresholds of viability should not be considered further and the project should be recommended for development.

Preliminary Screening: Cumulative Impact

This section provides an evaluation of the status of the wetland in a temporal and spatial context. It indicates the degree to which the wetland has been impacted previously by direct or indirect human induced activities and the degree to which the wetland will likely continue to deteriorate with and without the cumulative effects of the proposed project.

a. **Results of Past Effects upon the Wetland**

Has the wetland decreased in size during the past five years?

☐ Yes
☒ No
☐ Don't know (go to "3.2.3")
If yes, by how much: ☐ Highly affected
☐ Moderately affected
☐ Minimally affected

Is the wetland known to be detrimentally affected by other nearby projects or drainage system changes?

☒ Yes
☐ No
☐ Don't know (go to "3.2.3")
If yes, by how much: ☐ Highly affected
☒ Moderately affected
☐ Minimally affected

Have animal or plant communities been detrimentally impacted by past activity?

☒ Yes
☐ No
☐ Don't know (go to "4.0")
If yes, by how much: ☐ Highly affected
☒ Moderately affected
☐ Minimally affected

Have the wetland hydrological characteristics been detrimentally affected by other nearby activities?

☒ Yes

☐ No

☐ Don't know (go to "4.0")

If yes, by how much: ☐ Highly affected
☐ Moderately affected
☒ Minimally affected

b. **Potential Rehabilitation/Restoration**

Can the wetland be rehabilitated/restored?

☒ Likely

☐ Unlikely

☐ Very Unlikely

At what cost?

☐ Very Costly

☐ Costly

☒ Not Very Costly

c. **Wetland Status**

This item relates to the degree to which the cumulative impacts have passed an acceptable threshold level, and the wetland is beyond restorative assistance. Wetlands that are considered "lost" do not warrant further consideration unless they represent one of the last wetlands of their type in the region.

Has the wetland been compromised up to or beyond its viability as a functioning wetland?

☐ Yes (if yes, then complete next question"

☒ No (if no, go to Stage One (see Section 3.2.3).

Have most similar wetland types been lost to conversion in the region?

☐ Yes (if yes, go to "d. Recommendation" and consider (1) and (2)

☒ No (if no, go to "d. Recommendation" and consider (3) and (4)

d. **Recommendation**

☐ (1) Protect wetland as a representative or unique example.

☐ (2) Consider restoration/rehabilitation of wetland.

☐ (3) Consider proceeding with development if cumulative impact on wetlands are already high.

☒ (4) Proceed to Section 3.2.3, Stage One.

If recommendation 1, 2, or 3 accepted, stop evaluation here.

Evaluator's Signature **Date**

CONCLUSION OF CUMULATIVE IMPACT ASSESSMENT

Name of Wetland Wetland 6 Antigonish, Nova Scotia
Name *Area/Town/Province/Territory*

Complete this evaluation in a sequential manner.

3.2.3 Stage One "General Analysis"

The "General Analysis" is designed to provide land use planners, administrators, developers, and the public with an opportunity to examine the relative value of wetlands, and any proposed projects which may directly or indirectly impact those wetland values. This "General Analysis" sets out a process of easily identifying - from readily available public data - biological, hydrological and biogeochemical, social/cultural, and production wetland functions and the expected new production functions generated by the proposed project. All considerations are at an international, national, or provincial level of significance. A few are also at a regional scale of consideration.

Comparing the importance of the wetland and the project, provides the evaluator with knowledge about the desirability of : (1) protecting the wetland because it has outstanding value; (2) approving the project because it has outstanding value and the wetland has little or no value; and (3) deferring to Stage Two because no conclusion is obvious. The ratings provide guidance only to the recommendations.

Note: When listing sources, indicate relevant documents, authorities, and agencies.

Stage One Evaluation undertaken by:
Name Jacques Whitford Environment Limited
Address 3 Spectacle Lake Drive, Dartmouth, Nova Scotia B3B 1W8

Stage One values are based upon obvious, easily verified findings. Lack of sufficient information or inconclusive results will trigger the Stage Two applications. Values allocated are:

H = High value (3); M = Moderate Value (2); L = Low Value (1); NA= Not Applicable (X)

Where information is not available or unknown, check additional sources. If still unavailable or unknown, then automatically proceed to Stage Two Detailed Analysis.

3.2.3.1 Biological Component: Importance to Wildlife/Plant Communities

Potential Source of Data:
- Territorial/Provincial Wildlife or Natural Resources Agency
- University/Community College, Botany and Biology Departments
- Canadian Wildlife Service/Wildlife Habitat Canada office
- Local Ducks Unlimited Canada office
- Canada Land Inventory (Agriculture and Agri-Food Canada)

i. **Significance for Waterfowl/Wildlife Species**

This relates to the importance, at a national or provincial scale of significance, of the wetland as a habitat for the production, migration, or other life history events for waterfowl and other animal species at a national or provincial scale of significance. (Select most current classification, and shade numbers in either the Canada Land Inventory box OR the Provincial/Territorial Classification box. Enter shaded numbers on the lines beside each column and their sum on the subtotal line).

Canada Land Inventory	High (Class 1-2)	Moderate (Class 3-4)	Low (Class 5-7)	Not Available	
Waterfowl	3	2	1	X	
Wildlife	3	2	1	X	

Subtotal (maximum is 6)
(Where "x" occurs, go to "Stage Two Detailed Analysis"). ______

or

Provincial/Territorial Classification	High	Moderate	Low	Not Available	
Waterfowl	3	2	1	X	1
Wildlife	3	2	1	X	1

Subtotal (maximum is 6)
(Where "x" occurs, go to "Stage Two Detailed Analysis"). 2

Source
Wetland Atlas - Wetland Protection Mapping (Canadians Wildlife Services 1984)
Wetland Survey Conducted in the Wetland (2002)

ii. **Rarity/Scarcity or Uniqueness**

This relates to the degree to which the wildlife and vegetation species and populations inhabiting the wetland are rare, endangered or vulnerable within the region. (shade numbers and total them).

	High	Moderate	Low	Not Available	
Waterfowl/Wildlife	3	2	1	X	1
Vegetation	3	2	1	X	1

Subtotal (maximum is 6) 2
(Where "x" occurs, go to "Stage Two Detailed Analysis").

Source
Andrew Hebda, Curator of Zoology, Nova Scotia Museum of Natural History
Marian Munroe Curator of Botany, Nova Scotia Museum of Natural History
Atlas of Rare, Threatened and Infrequent Fauna of Nova Scotia (Fuller 1998, internal document)
Atlas of Rare Vascular Plants in Nova Scotia (Pronych and Wilson 1993)
Atlas of Breeding Birds of the Maritime Provinces (Erskine 1992)
The Amphibians and Reptiles of Nova Scotia (Gilhen 1984)
Stefen Gerriets, Data Manager, Atlantic Canada Conservation Data Centre
Vegetation and wildlife surveys conducted within wetland.

Total Biological Component Rating: 4

(Maximum is 12)
(Add "i" + "ii" subtotal, transfer total to equation in 3.2.3.6).

3.2.3.2 Hydrological Component: Water Quality/Groundwater/Erosion Control/Flood Control

This relates to the importance of the wetland for valued hydrological functions. It may be a general rating based on interviews with water analysts.

Source of Data: • Territorial/Provincial/Federal Water Resources Agencies
(shade numbers and total them)

	High	Moderate	Low	Not Available	
Significance of Contribution to Provincial Regional Water Quality/Groundwater	3	2	1	X	1
Significance of Contribution to Provincial/Regional Erosion Control/Flood Control	3	2	1	X	2

Total Hydrological Rating (maximum is 6) 3
(transfer total to "3.3.3.6")

Source Wetland Survey and consultation with hydrologist (Hans Arisz, Hydrocom Technologies Ltd.).

3.2.3.3 Social/Cultural Component: Contribution to Quality of Life

This relates to the existing public commitment to the wetland as exemplified by way of current legislated actions that protect significant wetland resources.

Sources of Data:
- Territorial/Provincial Lands Branch
- Territorial/Provincial Planning Branch
- Territorial/Provincial Environment Branch

(shade numbers and total them)

	High	Moderate	Low	
Existing, Proposed or Potential International/National/Provincial/Regional Heritage Designation or Protected Status (within or adjacent to the protected area).	3	2	1	1

Total Social/Cultural Rating (maximum is 3) 1
(transfer total to "3.2.3.6")

Source
Mark Pulsifer, Department of Natural Resources
Beardmore (1985)
Rachel Gautreau, Canadian Wildlife Service
Stefen Garriets, Data Manager, Atlantic Canada Conservation Data Centre

3.2.3.4 Production Component: Expected New Project Benefits

This relates to the potential new added value production benefits which may result from implementation of the project, both geographically and within the economic sectors.

Sources of Data:
- The proponent
- Territorial/Provincial Economic Development Agency
- Municipal/Regional Economic Development Office

(shade number and total them)

	High	Moderate	Low	
Significance of Project to the Economic Sector (e.g. agriculture, forestry, or tourism)	3	2	1	3
Economic Significance to National, Provincial, Regional Development and Employment	3	2	1	3

Total Production Component Rating (maximum is 6) 4
(transfer total to "3.2.3.6")

Source Louis Berger (Canada) Ltd. (1996)
Beasy Nicoll Engineering Ltd. (1999)

3.2.3.5 Copy of All Relevant Findings and Sources Attached

☐ Yes
☒ No
If no, then list

Information collected during the wetland survey are presented in Tables I1 and I2. A list of sources of existing data used in the evaluation is presented below.

Beasy Nicoll Engineering Limited. 1999. Highway 104 Antigonish Safety Review. Dartmouth, NS

Bond, W.K., K.W. Cox, T. Heberlein, E.W. Manning, D.R. Witty, and D.A. Young. 1992. Wetland Evaluation Guide. North American Wetlands Conservation Council (Canada), Issues Paper, No. 1992-1

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002. Canadian Species at Risk.

Erskine, A.J. 1992. Atlas of Breeding Birds of the Maritime Provinces. Nimbus Publishing and the Nova Scotia Museum, Halifax, N.S.

Fuller, S. 1998. Atlas of Rare, Threatened and Infrequent Fauna of Nova Scotia. Nova Scotia Museum of Natural History draft internal document, Halifax, NS.

Gilhen, J. 1984. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum, Halifax, N.S

Louis Berger (Canada) Ltd. 1996. An Assessment of the Economic Impact of Upgrading the Trans Canada Highway 104 To a Four-Lane, Divided, Controlled Access Highway Through Antigonish County. Atlantic Expressway Committee, Antigonish, NS.

NSDNR (Nova Scotia Department of Natural Resources). 2002a. General Status Ranks of Wild Species in Nova Scotia. Internet Publication: http://www.gov.ns.ca/natr/wildlife/genstatus/specieslist.asp.

NSDNR (Nova Scotia Department of Natural Resources). 2002b. Species at Risk in Nova Scotia. Internet Publication: http://www.gov.ns.ca/natr/wildlife/endngrd/specieslist.htm.

Pronych and Wilson, 1993. Atlas of Rare Vascular Plants in Nova Scotia. Curatorial Report No.78. Nova Scotia Museum of Natural History, Halifax, NS.

ACCDC (Atlantic Canada Conservation Data Centre). 2002. Species Lists and Rare Species. Internet Publication: http://www.accdc.com/info/lists/.

Scott, F.W. 1994. Provisional Annotated List of Plant and Animal Species Considered to be Rare in Nova Scotia. Nova Scotia Museum of Natural History. Halifax, NS.

Describe other major issues relevant to a decision As discussed in the Highway 104 Antigonish Environmental Assessment Report (Sections 2.1 and 6.4), the upgrade of the Highway is necessary due to increasing traffic volumes and concerns for public safety. The Five Year (1996 to 2000) blended or combined PDO collision rates for the 12.1 km of highway within the study area are about 40% higher than the comparable five year average for all provincial 100 series highways without access control. A detailed route selection process was undertaken by NSTPW to evaluate a number of options and select one alignment based on consideration of safety, and environmental and socio-economic constraints. The selected alignment is based on this evaluation and proposes to minimize disturbance where possible; however it will impinge upon some wetlands that are unavoidable due to pre-existing development or further environmental constraints.

3.2.3.6 Overall Project Impact Rating

An overall project rating occurs when the preceding Sections (3.2.3.1 -3.2.3.4) are examined to compare the overall significance of the wetland to that of the proposed project. This significance is identified in the rating calculation which follows.

a. **Rating Calculation**
(insert total from previous Sections (3.2.3.1 - 3.2.3.4) in boxes provided, subtract total in Section 3.2.3.4. from total of 3.2.3.1 to 3.2.3.3 and calculate overall ratings)

Current Wetland Status

3.2.3.1 Biological Rating	4	(a)
3.2.3.2 Hydrological Rating	3	(b)
3.2.3.3 Social/Cultural Rating	1	(c)

Project Status

3.2.3.4 Projected Production Change Rate	4	(d)

Overall Rating=
a+b+c minus d = e 4

Note: When a value of "U" (unknown) or "NA" (not available) occurs, then proceed to either gather that information or move directly to Stage Two Detailed Analysis to address that requirement.

b. **Overall Rating**

The equation totals the three wetland function component values (a+b+c) and subtracts the new project production benefits value (d). The result is an overall rating (e) which represents the value of the wetland in relation to the benefits of the proposed project.

- Maximum possible value: 19
- Minimum possible value: 1
- Where overall rating is equal to or greater than 13, project rejection (or relocation) should be recommended.
- Where overall rating is equal to or less than 3, project approval should be recommended.
- Where overall rating is between 4 and 12 inclusive, project should be referred to Stage Two Detailed Analysis.

Recommendations

- ☐ (a) reject project
- ☐ (b) refer to Stage Two Detailed Analysis
- ☐ (c) approve without conditions
- ☒ (d) approve with conditions

(List necessary mitigative measures and measures to retain/enhance wetland functions of value to society in (e))

(e) mitigative measures 1) Construct wetland habitat along the edge of Wetland 6 to replace the 0.81 ha of habitat lost at this wetland. 2) Salvage wetland soils from disturbed portion of wetland to aid in rapid re-establishment of native plant communities in reconstructed wetland. 3) Test salvaged wetland soil to ensure that it will not release stored contaminants 4) Ensure that the hydrology of the wetland is maintained through proper culvert placement. 5) Implement erosion and sediment control measures to minimize sedimentation of wetland. 6) Minimize the area of wetland habitat lost or disturbed as a result of highway construction.

(f) reason for recommendation (note: outline by project benefits and important wetland functions/values lost or reduced do not simply report the number calculated)

The project will provide economic benefits to the local area as a result of construction activity and will improve public safety. Construction activity will result in the infilling of approximately 19 % of the total area of wetland habitat resulting in the loss of wildlife habitat. The wetland habitat lost to highway construction is not particularly valuable and does not support any rare or endangered species. Tall shrub dominated basin swamp is the only wetland habitat type lost as a result of highway construction. This is the most abundant wetland habitat type present in the vicinity of Antigonish. The only apparent social or cultural use of the wetland is timber harvesting which was conducted in the recent past. This activity has affected the northern half of the wetland. The timber harvesting operation appears to have had little effect on the wetland substrate and regeneration of the forest plant community is under way. There is also evidence of past hydrological alterations to the wetland which resulted in some tree mortality. The source of this change is not known for certain but may be related to either construction of a causeway across part of the wetland or construction of Highway 104. The wetland appears to have moderate value in regards to surface water flow regulation. It probably augments stream flow during low flow periods and helps to ameliorate flood conditions by slowing and temporarily storing flood waters. This function will not be lost as a result of highway construction since only a small proportion of the wetland will be infilled. The current functions of the wetland will be maintained provided that the hydrology of the wetland is not altered by construction activity. To this end, care must be taken in the design and construction of culverts for the new highway.

Evaluator's Signature **Date**

If referred to Stage Two Detailed analysis, outline particular project impacts or wetland functions/values that may be worthy of special attention.

CONCLUSION OF STAGE ONE "GENERAL ANALYSIS"

3.3 Wetland 11

3.3.1 Process

3.3.1.1 Background

Name Jacques Whitford Environment Limited

Address 3 Spectacle Lake Drive, Dartmouth, Nova Scotia B3B 1W8

Date December 23, 2002

3.3.1.2 Project

This section describes the proposed project. It is essential that the project be described before proceeding with this section.

f. **Summary of Project** (fill in and check the boxes)

Name of Project Construction of Highway 104 Antigonish

i. Is it a public or private project? ☒ Public ☐ Private
ii. Does it require land use approval? ☐ Yes ☒ No
iii. Where is it located? Antigonish, Antigonish County, Nova Scotia
iv. Is it proposed in or near a wetland? ☒ In ☐ Near
v. Will the wetland be fully or partially drained? ☐ Fully ☐ Partially
fully or partially dredged? ☐ Fully ☐ Partially
completely or partially filled? ☐ Completely ☒ Partially
fully or partially dyked? ☐ Fully ☐ Partially (Temporarily)
fully or partially flooded? ☐ Fully ☐ Partially
fully or partially enhanced/restored? ☐ Fully ☐ Partially
Other

g. **Type of Activity Proposed** (check appropriate boxes; if necessary describe under "other")

i. ☐ Industrial
ii. ☐ Commercial
iii. ☐ Residential
iv. ☐ Institutional
v. ☐ Recreational/Tourism
vi. ☐ Agriculture
vii. ☒ Transportation/Utility Corridor
viii. ☐ Habitat Development
ix. ☐ Forestry
x. ☐ Other (describe)
xi. Statement of Project Purpose To upgrade the highway near Antigonish to current standards for 100 series highway.
xii. Precise Description of Activity Construction of 15 km of twinned 100 series highway.

h. **Status of Project** (land use controls which might affect the project)

i. **Jurisdiction of Approving Authority**
☒ Federal
☒ Territorial/Provincial
☐ Municipal/Regional
☐ Native

ii. **Type of Mandatory Review**

Mandatory review required?

☒ Yes ☐ No

Environmental Impact Assessment required?

☒ Yes	☐ No	Federal
☒ Yes	☐ No	Territorial/Provincial
☐ Yes	☒ No	Municipal
☐ Yes	☒ No	Native

iii. **Does the project fall under Municipal Development Control?** (If yes continue, if no go to "iv")

Type of Control:

☐ Approved Development Plan
☐ Approved Zoning By-Law
☐ Approved Environmental Impact Assessment (EIA)
☐ Approved Performance Standards
☐ Other (described) ____________________

iv. **Status of Proposal**

☐ Not Submitted
☒ Under Review
☐ Approved
☐ Denied
☐ Under Appeal
☐ Requires Zoning

v. **Sources of Funding** (check one or more)

☐ Private Financing
☒ Public Financing
☐ Public Subsidy
If public subsidy, please name program ____________________

vi. **Level of Project Understanding/Refinement** (check one)

☐ At very preliminary stage; little or no economic cost/benefit analysis
☒ Preliminary stage; conceptual drawings, economic cost/benefit analysis, environmental impact considerations
☐ Detailed design; design drawings, cost/benefit analysis (all components), and Environmental Impact Assessment

vii. **Potential for Stewardship**

Stewardship represents landowner commitment to manage the wetland in society's interest. Does that potential exist for this wetland?

☐ Yes
☒ No
☐ Maybe
If yes or maybe, what steps are needed to institute a stewardship program? ____________________

d. **Project Production Summary**

This section examines the products (i.e. benefits and disbenefits) which the project might generate.

i. **Has an economic analysis been completed for the project?**

☒ Yes (continue to "ii")

☐ No (go to "iv")

If yes, by whom: ☐ by proponent in-house

☒ by professional consultant

☒ other (name/agency/organization) Louis Berger (Canada) Ltd. commissioned by the Atlantic Expressway Committee; Beasy Nicoll Engineering Ltd. commissioned by NSTPW

Information about analyst

Name Louis Berger (Canada) Ltd. / Beasy Nicoll Engineering Ltd.

Address Unknown /80 Eileen Stubbs Avenue Dartmouth NS

Telephone No. Unknown / 902-468-4740

Date Analysis Prepared June 1996/ January 1999

ii. **Status of Economic Findings** (evaluator's opinion only)

☒ Detailed, thorough economic findings

☐ Preliminary economic findings

☐ No economic findings (go to "iv")

☐ Information not available (g to "iv")

iii. **Summary of Findings/Project Benefits** (if no estimates, check box; if estimates are available indicate information on line provided)

☒ Permanent jobs (person/years)

☒ Permanent contribution to new area wages per year

☒ Permanent contribution to new area spending (total per year)

☐ Construction jobs (person/years) 167

☐ Construction contribution to new area wages per year $2 million

☐ Construction contribution to area spending (total per year) $74 million

☒ Increased production by type (e.g. agriculture, forestry, tourism)

☒ Other benefits

☒ Amenity Contribution

iv. **Summary of Potential Disbenefits** (check the appropriate boxes)

There are expected problems that may occur because of the project. These potential problems are the preliminary issues that will need to be addressed as part of the project review.

☒ Noise

☐ Air pollution

☒ Water pollution

☐ Water drawdown

☒ Habitat loss

☐ Aesthetic loss

☐ Recreational loss

☐ Economic loss

☐ Other

e. **Summary of Expected Level of Selected Project Impacts** (check box for high, moderate, or low)

The following table provides project information which will assist in subsequent considerations of potential project impact upon the wetland under review. This table summarizes the evaluator's views based upon existing known information.

POTENTIAL WETLAND IMPACTS	LEVEL OF EXPECTED IMPACT HIGH	MODERATE	LOW
Noise Pollution		✓	
Air Pollution			✓
Water Pollution			✓
Water Drawdown			✓
Habitat Loss			✓
Aesthetic Loss			✓
Recreational Loss			✓
Other			

POTENTIAL ECONOMIC IMPACTS	LEVEL OF EXPECTED IMPACT HIGH	MODERATE	LOW
Employment			✓
Training			✓
Construction Spending		✓	
Operation Spending			✓
Taxes			✓
Indirect Spending*			✓
Flood Protection			✓
Other			✓

* (e.g. Tourism)

f. **Project Summary** (project description, sources, and a summary of findings that may be useful in future analysis)

A project description and analysis of environmental effects is presented in the "Highway 104 Antigonish Environmental Assessment Report" prepared for Nova Scotia Department of Transportation & Public Works by Jacques Whitford Environment Limited

3.3.1.3 Wetland Description

This section describes the affected wetland. It is essential that the wetland be described before proceeding.

a. **Wetland Location**

Province/Territory	Nova Scotia
Common Place Name (if any)	Antigonish
Nearest Urban Centre	Antigonish
Legal Description (if any)	None

Land Description: ☐ Public
☒ Private
☐ Protected Area
☐ Other ______
If public, name of area/site (if any) ______

If protected, name of agency and status ______

b. **Map**
Show location of wetland and proposed project in relation to region. (Draw or place map here, or attach map and/or project plan to back of this page. Indicate direction of north and ensure that map contains a scale).

(See Figure 5.4).

c. **Wetland Context**
This provides a brief description of the wetland and preliminary relationship to the project.

i. **Wetland Complexity**

			Size
Is this a single wetland	☐ Yes	☒ No	______ ha ( ) acres
Is this a wetland complex*	☒ Yes	☐ No	2.93 ha ( ) acres

(*i.e. a series of more than one wetland)

ii. **Wetland Class**

a) **Single Wetland** (Check one only)	b) **Wetland Complex** (Check all classes present, and write number if it occurs more than once)	c) **Wetland Classification**
☐ Bog	☐ Bog ______	☐ Temporary
☐ Fen	☐ Fen ______	☐ Seasonal
☐ Swamp	☒ Swamp Two types	☒ Permanent
☐ Marsh	☐ Marsh ______	
☐ Shallow Water	☐ Shallow Water	

iii. **Has this wetland been previously impacted?**
☐ Yes ☒ No
If yes, describe ______

Additional Comments Regarding Wetland Description

See Table 11 for a description of the wetland.

3.3.2 Preliminary Screening

This section examines two key considerations prior to the application of the three evaluation stages. These considerations relate to:

1. Potential for project relocations
2. Project redesign
3. Wetland viability

3.3.2.1 Potential for Project Relocation

This section examines the possibility of relocating the project away from the wetland, in order to reduce potential direct or indirect effects that may occur. It should be completed in association with the proponent. **(The proponent should be made aware of the subsequent evaluations procedure which may be necessary if relocation is not undertaken or is not possible).**

a. **How important is the wetland site for this project?**
☐ Essential (go to 3.3.2.2)
☒ Important (go to 3.3.2.2)
☐ Desirable (go to 3.3.2.2)
☐ Unnecessary (go to "b")
☐ Unknown (go to 3.3.2.2)

b. **Is an alternative location available?**
☐ Yes Where? (go to "c")
☐ No (go to 3.3.2.2)

c. **Does an alternative locations create detrimental impacts to other uses?**
☐ Yes (go to 3.3.2.2)
☐ No (go to "d")

d. **What is the rationale for relocation of the project, or why must it be located on this wetland site?**

____

e. **Project recommended for relocation?**
☐ Yes (go to "f")
☐ No (go to 3.3.2.2)

f. **Is proponent prepared to relocate?**
☐ Yes (if alternative location recommended and proponent accepts evaluation, stop here)
☐ No (go to 3.3.2.2)

______________________________ ______________________
Evaluator's Signature **Date**

CONCLUSION OF ALTERNATIVE PROJECT SITE CONSIDERATION

3.3.2.2 Project Redesign

A proposed project may require a simple or difficult redesign or change in project management practices to minimize wetland effects. This section examines that opportunity. You may need to reconsider this section after the Stage One and Stage Two evaluations.

a. **Is project redesign possible?**
- ☐ Very likely (go to "b")
- ☐ Possibly (go to "b")
- ☒ Not Possible (go to "f")

b. **Will the redesign significantly reduce the impact to the wetland?**
- ☐ Yes (go to "c")
- ☐ No (go to "f")

c. **If the project can be redesigned, will a redesign require other conditions?**
- ☐ Yes (go to "d")
- ☐ No (go to "f")

d. **What are the conditions for redesign?**
- ☐ Rezoning of other land
- ☐ Subsidies
- ☐ Other (specify) ____________________

e. **Are these conditions achievable?**
- ☐ Very likely (go to "j")
- ☐ Possibly (go to "j")
- ☐ Not Possible (go to "3.3.2.3")

  If not possible, why? ____________________

f. **Are changes in the way the project is managed possible?**
(e.g. landscaping, cultivation practices, design of infrastructure)
- ☐ Very likely (go to "g")
- ☒ Possibly (go to "g")
- ☐ Not Possible (go to "3.3.2.3")

g. **Will changes in the way the project is managed significantly reduce impact to the wetland?**
- ☐ Yes (go to "h")
- ☒ No (go to "3.3.2.3")

h. **What are the conditions for a change in the way the project is managed?**
- ☐ Subsidies
- ☐ Alteration to regulations
- ☐ Other (specify) ____________________

i. **Are these conditions achievable?**
- ☐ Very likely (go to "j")
- ☐ Possibly (go to "j")
- ☐ Not Possible (go to "3.3.2.3")

  If not possible, why? ____________________

j. **Interim Recommendations**
- ☐ The project should be redesigned; or
- ☐ The way the project is managed should be modified; or
- ☐ The proponent and approving authority will proceed to modify the project to protect the wetland.
- ☐ The evaluation should proceed.

The evaluator should consider such redesign or management practices in association with the proponent and/or the approving authority. Once discussions have been held, the evaluator should proceed to complete "k".

k. **Record of Action**
☐ Project satisfactorily redesigned; or
☐ Project management practices satisfactorily modified; or
☒ Proceed to Section 3.3.2.3

Additional Comments Regarding Project Redesign Considerations

None

CONCLUSION OF PROJECT REDESIGN CONSIDERATION

3.3.2.3 Wetland Viability

Wetland viability is the key consideration in the process of wetland and proposed project evaluation. A wetland, which has been severely and detrimentally affected over time and cannot be reasonably rehabilitated, should be considered for detailed analysis in Stage Two, only if it represents one of the last such wetland types in the region. Otherwise, a wetland that has been impacted previously beyond critical thresholds of viability should not be considered further and the project should be recommended for development.

Preliminary Screening: Cumulative Impact

This section provides an evaluation of the status of the wetland in a temporal and spatial context. It indicates the degree to which the wetland has been impacted previously by direct or indirect human induced activities and the degree to which the wetland will likely continue to deteriorate with and without the cumulative effects of the proposed project.

a. **Results of Past Effects upon the Wetland**

Has the wetland decreased in size during the past five years?
☐ Yes
☒ No
☐ Don't know (go to "stage 2 detailed analysis")
If yes, by how much: ☐ Highly affected
☐ Moderately affected
☐ Minimally affected

Is the wetland known to be detrimentally affected by other nearby projects or drainage system changes?
☐ Yes
☒ No
☐ Don't know (go to "stage 2 detailed analysis")
If yes, by how much: ☐ Highly affected
☐ Moderately affected
☐ Minimally affected

Have animal or plant communities been detrimentally impacted by past activity?
☐ Yes
☒ No
☐ Don't know (go to "stage 2 detailed analysis")
If yes, by how much: ☐ Highly affected
☐ Moderately affected
☐ Minimally affected

Have the wetland hydrological characteristics been detrimentally affected by other nearby activities?

☐ Yes
☒ No
☐ Don't know (go to "stage 2 detailed analysis")

If yes, by how much: ☐ Highly affected
☐ Moderately affected
☐ Minimally affected

b. **Potential Rehabilitation/Restoration**

Can the wetland be rehabilitated/restored?

☒ Likely
☐ Unlikely
☐ Very Unlikely

At what cost?

☐ Very Costly
☐ Costly
☒ Not Very Costly

c. **Wetland Status**

This item relates to the degree to which the cumulative impacts have passed an acceptable threshold level, and the wetland is beyond restorative assistance. Wetlands that are considered "lost" do not warrant further consideration unless they represent one of the last wetlands of their type in the region.

Has the wetland been compromised up to or beyond its viability as a functioning wetland?

☐ Yes (if yes, then complete next question"
☒ No (if no, go to Stage One (see Section 3.3.3).

Have most similar wetland types been lost to conversion in the region?

☐ Yes (if yes, go to "d. Recommendation" and consider (1) and (2)
☒ No (if no, go to "d. Recommendation" and consider (3) and (4)

d. **Recommendation**

☐ (1) Protect wetland as a representative or unique example.
☐ (2) Consider restoration/rehabilitation of wetland.
☐ (3) Consider proceeding with development if cumulative impact on wetlands are already high.
☒ (4) Proceed to Section 3.3.3, Stage One.

If recommendation 1, 2, or 3 accepted, stop evaluation here.

Evaluator's Signature

Date

CONCLUSION OF CUMULATIVE IMPACT ASSESSMENT

Name of Wetland Wetland 11 Antigonish, Nova Scotia
Name *Area/Town/Province/Territory*

Complete this evaluation in a sequential manner.

3.3.3 Stage One "General Analysis"

The "General Analysis" is designed to provide land use planners, administrators, developers, and the public with an opportunity to examine the relative value of wetlands, and any proposed projects which may directly or indirectly impact those wetland values. This "General Analysis" sets out a process of easily identifying - from readily available public data - biological, hydrological and biogeochemical, social/cultural, and production wetland functions and the expected new production functions generated by the proposed project. All considerations are at an international, national, or provincial level of significance. A few are also at a regional scale of consideration.

Comparing the importance of the wetland and the project, provides the evaluator with knowledge about the desirability of : (1) protecting the wetland because it has outstanding value; (2) approving the project because it has outstanding value and the wetland has little or no value; and (3) deferring to Stage Two because no conclusion is obvious. The ratings provide guidance only to the recommendations.

Note: When listing sources, indicate relevant documents, authorities, and agencies.

Stage One Evaluation undertaken by:
Name Jacques Whitford Environment Limited
Address 3 Spectacle Lake Drive, Dartmouth, Nova Scotia B3B 1W8

Stage One values are based upon obvious, easily verified findings. Lack of sufficient information or inconclusive results will trigger the Stage Two applications. Values allocated are:

H = High value (3); M = Moderate Value (2); L = Low Value (1); NA= Not Applicable (X)

Where information is not available or unknown, check additional sources. If still unavailable or unknown, then automatically proceed to Stage Two Detailed Analysis.

3.3.3.1 Biological Component: Importance to Wildlife/Plant Communities

Potential Source of Data:
- Territorial/Provincial Wildlife or Natural Resources Agency
- University/Community College, Botany and Biology Departments
- Canadian Wildlife Service/Wildlife Habitat Canada office
- Local Ducks Unlimited Canada office
- Canada Land Inventory (Agriculture and Agri-Food Canada)

i. **Significance for Waterfowl/Wildlife Species**
This relates to the importance, at a national or provincial scale of significance, of the wetland as a habitat for the production, migration, or other life history events for waterfowl and other animal species at a national or provincial scale of significance. (Select most current classification, and shade numbers in either the Canada Land Inventory box OR the Provincial/Territorial Classification box. Enter shaded numbers on the lines beside each column and their sum on the subtotal line).

Canada Land Inventory	High (Class 1-2)	Moderate (Class 3-4)	Low (Class 5-7)	Not Available	
Waterfowl	3	2	1	X	
Wildlife	3	2	1	X	

Subtotal (maximum is 6)
(Where "x" occurs, go to "Stage Two Detailed Analysis"). ________

or

Provincial/Territorial Classification	High	Moderate	Low	Not Available	
Waterfowl	3	2	1	X	1
Wildlife	3	2	1	X	1

Subtotal (maximum is 6)
(Where "x" occurs, go to "Stage Two Detailed Analysis"). 2

Source Wetland Atlas - Wetland Protection Mapping (Canadians Wildlife Services 1984)
Wetland Survey Conducted in the Wetland (2002)

ii. **Rarity/Scarcity or Uniqueness**

This relates to the degree to which the wildlife and vegetation species and populations inhabiting the wetland are rare, endangered or vulnerable within the region. (shade numbers and total them).

	High	Moderate	Low	Not Available	
Waterfowl/Wildlife	3	2	1	X	1
Vegetation	3	2	1	X	1

Subtotal (maximum is 6) 2
(Where "x" occurs, go to "Stage Two Detailed Analysis").

Source Andrew Hebda, Curator of Zoology, Nova Scotia Museum of Natural History
Marian Munroe, Curator of Botany, Nova Scotia Museum of Natural History
Stefen Garriets, Data Manager, Atlantic Canada Conservation Data Centre
Atlas of Rare, Threatened and Infrequent Fauna of Nova Scotia (Fuller 1998, internal document)
Atlas of Rare Vascular Plants in Nova Scotia (Pronych and Wilson 1993)
Atlas of Breeding Birds of the Maritime Provinces (Erskine 1992)
The Amphibians and Reptiles of Nova Scotia (Gilhen 1984)
Atlantic Canada Conservation Data Centre general status ranks for vascular plants, birds, mammals, reptiles and amphibians.
Nova Scotia Department of Natural Resources General Status Ranks of Wild Species in Nova Scotia (Vascular plants, birds, mammals, reptiles and amphibians).
Vegetation and wildlife surveys conducted within wetland.

Total Biological Component Rating: 4

(Maximum is 12)
(Add "i" + "ii" subtotal, transfer total to equation in "3.3.3.6).

3.3.3.2 Hydrological Component: Water Quality/Groundwater/Erosion Control/Flood Control

This relates to the importance of the wetland for valued hydrological functions. It may be a general rating based on interviews with water analysts.

Source of Data: • Territorial/Provincial/Federal Water Resources Agencies

(shade numbers and total them)

	High	Moderate	Low	Not Available	
Significance of Contribution to Provincial Regional Water Quality/Groundwater	3	2	1	X	1
Significance of Contribution to Provincial/Regional Erosion Control/Flood Control	3	2	1	X	2

Total Hydrological Rating (maximum is 6) 3
(transfer total to "3.3.3.6")

Source Wetland Survey and consultation with hydrologist (Hans Arisz, Hydrocom Technologies Ltd.).

3.3.3.3 Social/Cultural Component: Contribution to Quality of Life

This relates to the existing public commitment to the wetland as exemplified by way of current legislated actions that protect significant wetland resources.

Sources of Data:
- Territorial/Provincial Lands Branch
- Territorial/Provincial Planning Branch
- Territorial/Provincial Environment Branch

(shade numbers and total them)

	High	Moderate	Low	
Existing, Proposed or Potential International/National/Provincial/Regional Heritage Designation or Protected Status (within or adjacent to the protected area).	3	2	1	1

Total Social/Cultural Rating (maximum is 3) 1
(transfer total to "3.3.3.6")

Source Stefen Garriets, Data Manager, Atlantic Canada Conservation Data Centre
Beardmore (1985)
Mark Pulsifer, Nova Scotia Department of Natural Resources
Rachel Gautreau, Canadian Wildlife Service

3.3.3.4 Production Component: Expected New Project Benefits

This relates to the potential new added value production benefits which may result from implementation of the project, both geographically and within the economic sectors.

Sources of Data:
- The proponent
- Territorial/Provincial Economic Development Agency
- Municipal/Regional Economic Development Office

(shade number and total them)

	High	Moderate	Low	
Significance of Project to the Economic Sector (e.g. agriculture, forestry, or tourism)	3	2	1	2
Economic Significance to National, Provincial, Regional Development and Employment	3	2	1	2

Total Production Component Rating (maximum is 6) 4
(transfer total to "3.3.3.6")

Source Louis Berger (Canada) Ltd (1996)
Beasy Nicoll Engineering Ltd. (1999)

3.3.3.5 Copy of All Relevant Findings and Sources Attached

☐ Yes
☒ No
If no, then list

Information collected during the wetland survey are presented in Tables I1 and I2. A list of sources of existing data used in the evaluation is presented below.

Beasy Nicoll Engineering Limited. 1999. Highway 104 Antigonish Safety Review. Dartmouth, NS

Bond, W.K., K.W. Cox, T. Heberlein, E.W. Manning, D.R. Witty, and D.A. Young. 1992. Wetland Evaluation Guide. North American Wetlands Conservation Council (Canada), Issues Paper, No. 1992-1

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002. Canadian Species at Risk

Erskine, A.J. 1992. Atlas of Breeding Birds of the Maritime Provinces. Nimbus Publishing and the Nova Scotia Museum, Halifax, N.S.

Fuller, S. 1998. Atlas of Rare, Threatened and Infrequent Fauna of Nova Scotia. Nova Scotia Museum of Natural History draft internal document, Halifax, N.S.

Gilhen, J. 1984. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum, Halifax, N.S

Louis Berger (Canada) Ltd. 1996. An Assessment of the Economic Impact of Upgrading the Trans Canada Highway 104 To a Four-Lane, Divided, Controlled Access Highway Through Antigonish County. Atlantic Expressway Committee, Antigonish, NS.

NSDNR (Nova Scotia Department of Natural Resources). 2002a. General Status Ranks of Wild Species in Nova Scotia. Internet Publication: http://www.gov.ns.ca/natr/wildlife/genstatus/specieslist.asp.

NSDNR (Nova Scotia Department of Natural Resources). 2002b. Species at Risk in Nova Scotia. Internet Publication: http://www.gov.ns.ca/natr/wildlife/endngrd/specieslist.htm.

Pronych and Wilson, 1993. Atlas of Rare Vascular Plants in Nova Scotia. Curatorial Report No.78. Nova Scotia Museum of Natural History, Halifax, N.S.

ACCDC (Atlantic Canada Conservation Data Centre). 2002. Species Lists and Rare Species. Internet Publication: http://www.accdc.com/info/lists/.

Scott, F.W. 1994. Provisional Annotated List of Plant and Animal Species Considered to be Rare in Nova Scotia. Nova Scotia Museum of Natural History. Halifax, N.S.

Stefen Garriets, Data Manager, Atlantic Canada Conservation Data Centre

Describe other major issues relevant to a decision As discussed in the Highway 104 Antigonish Environmental Assessment Report (Sections 2.1 and 6.4), the upgrade of the Highway is necessary due to increasing traffic volumes and concerns for public safety. The Five Year (1996 to 2000) blended or combined PDO collision rates for the 12.1 km of highway within the study area are about 40% higher than the comparable five year average for all provincial 100 series highways without access control. A detailed route selection process was undertaken by NSTPW to evaluate a number of options and select one alignment based on consideration of safety, and environmental and socio-economic constraints. The selected alignment is based on this evaluation and proposes to minimize disturbance where possible; however it will impinge upon some wetlands that are unavoidable due to pre-existing development or further environmental constraints.

3.3.3.6 Overall Project Impact Rating

An overall project rating occurs when the preceding Sections (3.3.3.1 - 3.3.3.4) are examined to compare the overall significance of the wetland to that of the proposed project. This significance is identified in the rating calculation which follows.

a. **Rating Calculation**
(insert total from previous Sections (3.3.3.1 -3.3.3.4) in boxes provided, subtract total in Section 3.3.3.4. from total of 3.3.3.1 to 3.3.3.3 and calculate overall ratings)

Current Wetland Status

3.3.3.1 Biological Rating	4	(a)
3.3.3.2 Hydrological Rating	3	(b)
3.3.3.3 Social/Cultural Rating	1	(c)

Project Status

3.3.3.4 Projected Production Change Rate	4	(d)

Overall Rating=
a+b+c minus d = e 4

Note: When a value of "U" (unknown) or "NA" (not available) occurs, then proceed to either gather that information or move directly to Stage Two Detailed Analysis to address that requirement.

b. **Overall Rating**

The equation totals the three wetland function component values (a+b+c) and subtracts the new project production benefits value (d). The result is an overall rating (e) which represents the value of the wetland in relation to the benefits of the proposed project.

- Maximum possible value: 19
- Minimum possible value: 1
- Where overall rating is equal to or greater than 13, project rejection (or relocation) should be recommended.
- Where overall rating is equal to or less than 3, project approval should be recommended.
- Where overall rating is between 4 and 12 inclusive, project should be referred to Stage Two Detailed Analysis.

Recommendations

- ☐ (a) reject project
- ☐ (b) refer to Stage Two Detailed Analysis
- ☐ (c) approve without conditions
- ☒ (d) approve with conditions
  (List necessary mitigative measures and measures to retain/enhance wetland functions of value to society in (e))

(e) mitigative measures 1) Construct wetland habitat along the edge of Wetland 11 to replace the 0.01 ha of habitat lost at this wetland. 2) Salvage wetland soils from disturbed portion of wetland to aid in rapid re-establishment of native plant communities in reconstructed wetland. 3) Test salvaged wetland soil to ensure that it will not release stored contaminants 4) Ensure that the hydrology of the wetland is maintained through proper culvert placement. 5) Implement erosion and sediment control measures to minimize sedimentation of wetland. 6) Minimize the area of wetland habitat lost or disturbed as a result of highway construction.

(f) reason for recommendation (note: outline by project benefits and important wetland functions/values lost or reduced do not simply report the number calculated)

The project will provide economic benefits to the local area as a result of construction activity and will improve public safety. The wetland survey and a review of the existing literature indicates that the wetland has limited value as wildlife habitat and as habitat for rare or endangered species. The shallow open water of the wetland provides habitat for a variety of amphibian species including Green frog, mink frog and leopard frog as well as fish species such as sticklebacks. Construction of the highway will result in the loss of approximately 0.5 % of the area of the wetland. This loss of wetland habitat is not expected to have a significant adverse effect on this function. The wetland has no known social/cultural attributes. The wetland plays a moderate role in flood control and surface water regulation. During low flow periods the wetland would augment stream flow and during periods of flooding it would slow the flow of flood waters. These hydrologic functions would not be lost since onl; a small area of the wetland would be infilled during highway construction.

Evaluator's Signature **Date**

If referred to Stage Two Detailed analysis, outline particular project impacts or wetland functions/values that may be worthy of special attention.

CONCLUSION OF STAGE ONE "GENERAL ANALYSIS"

3.4 Wetland 12

3.4.1 Process

3.4.1.1 Background

Name Jacques Whitford Environment Limited

Address 3 Spectacle Lake Drive, Dartmouth, Nova Scotia B3B 1W8

Date December 23, 2002

3.4.1.2 Project

This section describes the proposed project. It is essential that the project be described before proceeding with this section.

f. **Summary of Project** (fill in and check the boxes)

Name of Project Construction of Highway 104 Antigonish

i.	Is it a public or private project?	☒ Public ☐ Private	
ii.	Does it require land use approval?	☐ Yes	☒ No
iii.	Where is it located? Antigonish, Antigonish County, Nova Scotia		
iv.	Is it proposed in or near a wetland?	☒ In	☐ Near
v.	Will the wetland be fully or partially drained?	☐ Fully	☐ Partially
	fully or partially dredged?	☐ Fully	☐ Partially
	completely or partially filled?	☐ Completely	☒ Partially
	fully or partially dyked?	☐ Fully	☐ Partially (Temporarily)
	fully or partially flooded?	☐ Fully	☐ Partially
	fully or partially enhanced/restored?	☐ Fully	☐ Partially
	Other		

g. **Type of Activity Proposed** (check appropriate boxes; if necessary describe under "other")

i. ☐ Industrial
ii. ☐ Commercial
iii. ☐ Residential
iv. ☐ Institutional
v. ☐ Recreational/Tourism
vi. ☐ Agriculture
vii. ☒ Transportation/Utility Corridor
viii. ☐ Habitat Development
ix. ☐ Forestry
x. ☐ Other (describe)
xi. Statement of Project Purpose To upgrade the highway near Antigonish to current standards for 100 series highway.
xii. Precise Description of Activity Construction of 15 km of twinned 100 series highway.

h. **Status of Project** (land use controls which might affect the project)

i. **Jurisdiction of Approving Authority**
☒ Federal
☒ Territorial/Provincial
☐ Municipal/Regional
☐ Native

ii. **Type of Mandatory Review**

Mandatory review required?

☒ Yes ☐ No

Environmental Impact Assessment required?

☒ Yes	☐ No	Federal
☒ Yes	☐ No	Territorial/Provincial
☐ Yes	☒ No	Municipal
☐ Yes	☒ No	Native

iii. **Does the project fall under Municipal Development Control?** (If yes continue, if no go to "iv")

Type of Control:

☐ Approved Development Plan
☐ Approved Zoning By-Law
☐ Approved Environmental Impact Assessment (EIA)
☐ Approved Performance Standards
☐ Other (described) ____________________

iv. **Status of Proposal**

☐ Not Submitted
☒ Under Review
☐ Approved
☐ Denied
☐ Under Appeal
☐ Requires Zoning

v. **Sources of Funding** (check one or more)

☐ Private Financing
☒ Public Financing
☐ Public Subsidy
If public subsidy, please name program ____________________

____

vi. **Level of Project Understanding/Refinement** (check one)

☐ At very preliminary stage; little or no economic cost/benefit analysis
☒ Preliminary stage; conceptual drawings, economic cost/benefit analysis, environmental impact considerations
☐ Detailed design; design drawings, cost/benefit analysis (all components), and Environmental Impact Assessment

vii. **Potential for Stewardship**

Stewardship represents landowner commitment to manage the wetland in society's interest. Does that potential exist for this wetland?

☐ Yes
☒ No
☐ Maybe
If yes or maybe, what steps are needed to institute a stewardship program? ____________________

____

d. **Project Production Summary**

This section examines the products (i.e. benefits and disbenefits) which the project might generate.

i. **Has an economic analysis been completed for the project?**

☒ Yes (continue to "ii")
☐ No (go to "iv")
If yes, by whom: ☐ by proponent in-house
☒ by professional consultant
☒ other (name/agency/organization) Louis Berger (Canada) Ltd. commissioned by the Atlantic Expressway Committee; Beasy Nicoll Engineering Ltd. commissioned by NSTPW

Information about analyst
Name Louis Berger (Canada) Ltd. / Beasy Nicoll Engineering Ltd.
Address Unknown /80 Eileen Stubbs Avenue Dartmouth NS
Telephone No. Unknown / 902-468-4740
Date Analysis Prepared June 1996/ January 1999

ii. **Status of Economic Findings** (evaluator's opinion only)

☒ Detailed, thorough economic findings
☐ Preliminary economic findings
☐ No economic findings (go to "iv")
☐ Information not available (g to "iv")

iii. **Summary of Findings/Project Benefits** (if no estimates, check box; if estimates are available indicate information on line provided)

☒ Permanent jobs (person/years)
☒ Permanent contribution to new area wages per year
☒ Permanent contribution to new area spending (total per year)
☐ Construction jobs (person/years) 167
☐ Construction contribution to new area wages per year $2 million
☐ Construction contribution to area spending (total per year) $74 million
☒ Increased production by type (e.g. agriculture, forestry, tourism)
☒ Other benefits
☒ Amenity Contribution

iv. **Summary of Potential Disbenefits** (check the appropriate boxes)

There are expected problems that may occur because of the project. These potential problems are the preliminary issues that will need to be addressed as part of the project review.

☒ Noise
☐ Air pollution
☒ Water pollution
☐ Water drawdown
☒ Habitat loss
☐ Aesthetic loss
☐ Recreational loss
☐ Economic loss
☐ Other

e. **Summary of Expected Level of Selected Project Impacts** (check box for high, moderate, or low)

The following table provides project information which will assist in subsequent considerations of potential project impact upon the wetland under review. This table summarizes the evaluator's views based upon existing known information.

POTENTIAL WETLAND IMPACTS	LEVEL OF EXPECTED IMPACT HIGH	MODERATE	LOW
Noise Pollution		✓	
Air Pollution			✓
Water Pollution			✓
Water Drawdown			✓
Habitat Loss			✓
Aesthetic Loss			✓
Recreational Loss			✓
Other			

POTENTIAL ECONOMIC IMPACTS	LEVEL OF EXPECTED IMPACT HIGH	MODERATE	LOW
Employment			✓
Training			✓
Construction Spending		✓	
Operation Spending			✓
Taxes			✓
Indirect Spending*			✓
Flood Protection			✓
Other			✓

* (e.g. Tourism)

f. **Project Summary** (project description, sources, and a summary of findings that may be useful in future analysis)

A project description and analysis of environmental effects is presented in the "Highway 104 Antigonish Environmental Assessment Report" prepared for Nova Scotia Department of Transportation & Public Works by Jacques Whitford Environment Limited

3.4.1.3 Wetland Description

This section describes the affected wetland. It is essential that the wetland be described before proceeding.

a. **Wetland Location**

Province/Territory Nova Scotia
Common Place Name (if any) Antigonish
Nearest Urban Centre Antigonish
Legal Description (if any) None

Land Description: ☐ Public
☒ Private
☐ Protected Area
☐ Other ______
If public, name of area/site (if any) ______

If protected, name of agency and status ______

b. **Map**
Show location of wetland and proposed project in relation to region. (Draw or place map here, or attach map and/or project plan to back of this page. Indicate direction of north and ensure that map contains a scale).

(See Figure 5.4).

c. **Wetland Context**
This provides a brief description of the wetland and preliminary relationship to the project.

i. **Wetland Complexity** **Size**
Is this a single wetland ☐ Yes ☒ No ______ ha ( ) acres
Is this a wetland complex* ☒ Yes ☐ No 7.22 ha ( ) acres
(*i.e. a series of more than one wetland)

ii. **Wetland Class**

a) **Single Wetland** (Check one only)	b) **Wetland Complex** (Check all classes present, and write number if it occurs more than once)	c) **Wetland Classification**
☐ Bog	☐ Bog ______	☐ Temporary
☐ Fen	☐ Fen ______	☐ Seasonal
☐ Swamp	☒ Swamp Three types	☒ Permanent
☐ Marsh	☐ Marsh ______	
☐ Shallow Water	☐ Shallow Water	

iii. **Has this wetland been previously impacted?**
☒ Yes ☐ No
If yes, describe Approximately 30 % of the wetland has been clear-cut (northeastern end of wetland). Recent beaver flooding has resulted in substantial changes to approximately 25 % of the wetland (western end of wetland).

Additional Comments Regarding Wetland Description

See Table I1 for a description of the wetland.

3.4.2 Preliminary Screening

This section examines two key considerations prior to the application of the three evaluation stages. These considerations relate to:

1. Potential for project relocations
2. Project redesign
3. Wetland viability

3.4.2.1 Potential for Project Relocation

This section examines the possibility of relocating the project away from the wetland, in order to reduce potential direct or indirect effects that may occur. It should be completed in association with the proponent. **(The proponent should be made aware of the subsequent evaluations procedure which may be necessary if relocation is not undertaken or is not possible).**

a. **How important is the wetland site for this project?**
   ☐ Essential (go to 3.4.2.2)
   ☒ Important (go to 3.4.2.2)
   ☐ Desirable (go to 3.4.2.2)
   ☐ Unnecessary (go to "b")
   ☐ Unknown (go to 3.4.2.2)

b. **Is an alternative location available?**
   ☐ Yes Where? (go to "c")
   ☐ No (go to 3.4.2.2)

c. **Does an alternative locations create detrimental impacts to other uses?**
   ☐ Yes (go to 3.4.2.2)
   ☐ No (go to "d")

d. **What is the rationale for relocation of the project, or why must it be located on this wetland site?**
   ____

e. **Project recommended for relocation?**
   ☐ Yes (go to "f")
   ☐ No (go to 3.4.2.2)

f. **Is proponent prepared to relocate?**
   ☐ Yes (if alternative location recommended and proponent accepts evaluation, stop here)
   ☐ No (go to 3.4.2.2)

______________________________ ________________________

Evaluator's Signature **Date**

CONCLUSION OF ALTERNATIVE PROJECT SITE CONSIDERATION

3.4.2.2 Project Redesign

A proposed project may require a simple or difficult redesign or change in project management practices to minimize wetland effects. This section examines that opportunity. You may need to reconsider this section after the Stage One and Stage Two evaluations.

a. **Is project redesign possible?**
   ☐ Very likely (go to "b")
   ☐ Possibly (go to "b")
   ☒ Not Possible (go to "f")

b. **Will the redesign significantly reduce the impact to the wetland?**
   ☐ Yes (go to "c")
   ☐ No (go to "f")

c. **If the project can be redesigned, will a redesign require other conditions?**
   ☐ Yes (go to "d")
   ☐ No (go to "f")

d. **What are the conditions for redesign?**
   ☐ Rezoning of other land
   ☐ Subsidies
   ☐ Other (specify) ______________________________

e. **Are these conditions achievable?**
   ☐ Very likely (go to "j")
   ☐ Possibly (go to "j")
   ☐ Not Possible (go to "3.4.2.3")
   If not possible, why? ______________________________

f. **Are changes in the way the project is managed possible?**
   (e.g. landscaping, cultivation practices, design of infrastructure)
   ☐ Very likely (go to "g")
   ☒ Possibly (go to "g")
   ☐ Not Possible (go to "3.4.2.3")

g. **Will changes in the way the project is managed significantly reduce impact to the wetland?**
   ☐ Yes (go to "h")
   ☒ No (go to "3.4.2.3")

h. **What are the conditions for a change in the way the project is managed?**
   ☐ Subsidies
   ☐ Alteration to regulations
   ☐ Other (specify) ______________________________

i. **Are these conditions achievable?**
   ☐ Very likely (go to "j")
   ☐ Possibly (go to "j")
   ☐ Not Possible (go to "3.4.2.3")
   If not possible, why? ______________________________

j. **Interim Recommendations**
   ☐ The project should be redesigned; or
   ☐ The way the project is managed should be modified; or
   ☐ The proponent and approving authority will proceed to modify the project to protect the wetland.
   ☐ The evaluation should proceed.

The evaluator should consider such redesign or management practices in association with the proponent and/or the approving authority. Once discussions have been held, the evaluator should proceed to complete "k".

k. **Record of Action**
☐ Project satisfactorily redesigned; or
☐ Project management practices satisfactorily modified; or
☒ Proceed to Section 3.4.2.3

Additional Comments Regarding Project Redesign Considerations

None

CONCLUSION OF PROJECT REDESIGN CONSIDERATION

3.4.2.3 Wetland Viability

Wetland viability is the key consideration in the process of wetland and proposed project evaluation. A wetland, which has been severely and detrimentally affected over time and cannot be reasonably rehabilitated, should be considered for detailed analysis in Stage Two, only if it represents one of the last such wetland types in the region. Otherwise, a wetland that has been impacted previously beyond critical thresholds of viability should not be considered further and the project should be recommended for development.

Preliminary Screening: Cumulative Impact

This section provides an evaluation of the status of the wetland in a temporal and spatial context. It indicates the degree to which the wetland has been impacted previously by direct or indirect human induced activities and the degree to which the wetland will likely continue to deteriorate with and without the cumulative effects of the proposed project.

a. **Results of Past Effects upon the Wetland**

Has the wetland decreased in size during the past five years?
☐ Yes
☒ No
☐ Don't know (go to "3.4.3")
If yes, by how much: ☐ Highly affected
☐ Moderately affected
☐ Minimally affected

Is the wetland known to be detrimentally affected by other nearby projects or drainage system changes?
☒ Yes
☐ No
☐ Don't know (go to "3.4.3")
If yes, by how much: ☐ Highly affected
☐ Moderately affected
☒ Minimally affected

Have animal or plant communities been detrimentally impacted by past activity?
☒ Yes
☐ No
☐ Don't know (go to "3.4.3")
If yes, by how much: ☐ Highly affected
☒ Moderately affected
☐ Minimally affected

Have the wetland hydrological characteristics been detrimentally affected by other nearby activities?
☐ Yes
☒ No
☐ Don't know (go to "3.4.3")
If yes, by how much: ☐ Highly affected
☐ Moderately affected
☐ Minimally affected

b. **Potential Rehabilitation/Restoration**

Can the wetland be rehabilitated/restored?
☒ Likely
☐ Unlikely
☐ Very Unlikely

At what cost?
☐ Very Costly
☐ Costly
☒ Not Very Costly

c. **Wetland Status**

This item relates to the degree to which the cumulative impacts have passed an acceptable threshold level, and the wetland is beyond restorative assistance. Wetlands that are considered "lost" do not warrant further consideration unless they represent one of the last wetlands of their type in the region.

Has the wetland been compromised up to or beyond its viability as a functioning wetland?
☐ Yes (if yes, then complete next question"
☒ No (if no, go to Stage One (see Section 3.4.3).

Have most similar wetland types been lost to conversion in the region?
☐ Yes (if yes, go to "d. Recommendation" and consider (1) and (2)
☒ No (if no, go to "d. Recommendation" and consider (3) and (4)

d. **Recommendation**
☐ (1) Protect wetland as a representative or unique example.
☐ (2) Consider restoration/rehabilitation of wetland.
☐ (3) Consider proceeding with development if cumulative impact on wetlands are already high.
☒ (4) Proceed to Section 3.4.3, Stage One.

If recommendation 1, 2, or 3 accepted, stop evaluation here.

Evaluator's Signature **Date**

CONCLUSION OF CUMULATIVE IMPACT ASSESSMENT

Name of Wetland Wetland 12 Antigonish, Nova Scotia
Name *Area/Town/Province/Territory*

Complete this evaluation in a sequential manner.

3.4.3 Stage One "General Analysis"

The "General Analysis" is designed to provide land use planners, administrators, developers, and the public with an opportunity to examine the relative value of wetlands, and any proposed projects which may directly or indirectly impact those wetland values. This "General Analysis" sets out a process of easily identifying - from readily available public data - biological, hydrological and biogeochemical, social/cultural, and production wetland functions and the expected new production functions generated by the proposed project. All considerations are at an international, national, or provincial level of significance. A few are also at a regional scale of consideration.

Comparing the importance of the wetland and the project, provides the evaluator with knowledge about the desirability of : (1) protecting the wetland because it has outstanding value; (2) approving the project because it has outstanding value and the wetland has little or no value; and (3) deferring to Stage Two because no conclusion is obvious. The ratings provide guidance only to the recommendations.

Note: When listing sources, indicate relevant documents, authorities, and agencies.

Stage One Evaluation undertaken by:
Name Jacques Whitford Environment Limited
Address 3 Spectacle Lake Drive, Dartmouth, Nova Scotia B3B 1W8

Stage One values are based upon obvious, easily verified findings. Lack of sufficient information or inconclusive results will trigger the Stage Two applications. Values allocated are:

H = High value (3); M = Moderate Value (2); L = Low Value (1); NA= Not Applicable (X)

Where information is not available or unknown, check additional sources. If still unavailable or unknown, then automatically proceed to Stage Two Detailed Analysis.

3.4.3.1 Biological Component: Importance to Wildlife/Plant Communities

Potential Source of Data:
- Territorial/Provincial Wildlife or Natural Resources Agency
- University/Community College, Botany and Biology Departments
- Canadian Wildlife Service/Wildlife Habitat Canada office
- Local Ducks Unlimited Canada office
- Canada Land Inventory (Agriculture and Agri-Food Canada)

i. **Significance for Waterfowl/Wildlife Species**

This relates to the importance, at a national or provincial scale of significance, of the wetland as a habitat for the production, migration, or other life history events for waterfowl and other animal species at a national or provincial scale of significance. (Select most current classification, and shade numbers in either the Canada Land Inventory box OR the Provincial/Territorial Classification box. Enter shaded numbers on the lines beside each column and their sum on the subtotal line).

Canada Land Inventory	High (Class 1-2)	Moderate (Class 3-4)	Low (Class 5-7)	Not Available	
Waterfowl	3	2	1	X	
Wildlife	3	2	1	X	

Subtotal (maximum is 6)
(Where "x" occurs, go to "Stage Two Detailed Analysis"). ________

or

Provincial/Territorial Classification	High	Moderate	Low	Not Available	
Waterfowl	3	2	1	X	1
Wildlife	3	2	1	X	1

Subtotal (maximum is 6)
(Where "x" occurs, go to "Stage Two Detailed Analysis"). 2

Source Wetland Atlas - Wetland Protection Mapping (Canadians Wildlife Services 1984)
Wetland Survey Conducted in the Wetland (2002)

ii. **Rarity/Scarcity or Uniqueness**

This relates to the degree to which the wildlife and vegetation species and populations inhabiting the wetland are rare, endangered or vulnerable within the region. (shade numbers and total them).

	High	Moderate	Low	Not Available	
Waterfowl/Wildlife	3	2	1	X	1
Vegetation	3	2	1	X	1

Subtotal (maximum is 6) 2
(Where "x" occurs, go to "Stage Two Detailed Analysis).

Source Andrew Hebda, Curator of Zoology, Nova Scotia Museum of Natural History
Marian Munroe, Curator of Botany, Nova Scotia Museum of Natural History
Stefen Garriets, Data Manager, Atlantic Canada Conservation Data Centre
Atlas of Rare, Threatened and Infrequent Fauna of Nova Scotia (Fuller 1998, internal document)
Atlas of Rare Vascular Plants in Nova Scotia (Pronych and Wilson 1993)
Atlas of Breeding Birds of the Maritime Provinces (Erskine 1992)
The Amphibians and Reptiles of Nova Scotia (Gilhen 1984)
Atlantic Canada Conservation Data Centre data request and general status ranks for vascular plants, birds, mammals, reptiles and amphibians.
Nova Scotia Department of Natural Resources General Status Ranks of Wild Species in Nova Scotia (Vascular plants, birds, mammals, reptiles and amphibians).
Vegetation and wildlife surveys conducted within wetland.

Total Biological Component Rating: 4

(Maximum is 12)
(Add "i" + "ii" subtotal, transfer total to equation in "3.4.3.6).

3.4.3.2 Hydrological Component: Water Quality/Groundwater/Erosion Control/Flood Control

This relates to the importance of the wetland for valued hydrological functions. It may be a general rating based on interviews with water analysts.

Source of Data: • Territorial/Provincial/Federal Water Resources Agencies
(shade numbers and total them)

	High	Moderate	Low	Not Available	
Significance of Contribution to Provincial Regional Water Quality/Groundwater	3	2	1	X	1
Significance of Contribution to Provincial/Regional Erosion Control/Flood Control	3	2	1	X	2

Total Hydrological Rating (maximum is 6) 3
(transfer total to "3.4.3.6")

Source Wetland Survey and consultation with hydrologist (Hans Arisz, Hydrocom Technologies Ltd.).

3.4.3.3 Social/Cultural Component: Contribution to Quality of Life

This relates to the existing public commitment to the wetland as exemplified by way of current legislated actions that protect significant wetland resources.

Sources of Data:
- Territorial/Provincial Lands Branch
- Territorial/Provincial Planning Branch
- Territorial/Provincial Environment Branch

(shade numbers and total them)

	High	Moderate	Low	
Existing, Proposed or Potential International/National/Provincial/Regional Heritage Designation or Protected Status (within or adjacent to the protected area).	3	2	1	1

Total Social/Cultural Rating (maximum is 3) 1
(transfer total to "3.4.3.6")

Source
Atlantic Canada Conservation Data Centre
Beardmore (1985) Mark Pulsifer, Nova Scotia Department of Natural Resources
Rachel Gautreau, Canadian Wildlife Service

3.4.3.4 Production Component: Expected New Project Benefits

This relates to the potential new added value production benefits which may result from implementation of the project, both geographically and within the economic sectors.

Sources of Data:
- The proponent
- Territorial/Provincial Economic Development Agency
- Municipal/Regional Economic Development Office

(shade number and total them)

	High	Moderate	Low	
Significance of Project to the Economic Sector (e.g. agriculture, forestry, or tourism)	3	2	1	2
Economic Significance to National, Provincial, Regional Development and Employment	3	2	1	2

Total Production Component Rating (maximum is 6) 4
(transfer total to "3.4.3.6")

Source Louis Berger (Canada) Ltd. (1996)
Beasy Nicoll Engineering Ltd. (1999)

3.4.3.5 Copy of All Relevant Findings and Sources Attached

☐ Yes
☒ No
If no, then list

Information collected during the wetland survey are presented in Tables I1 and I2. A list of sources of existing data used in the evaluation is presented below.

Beasy Nicoll Engineering Limited. 1999. Highway 104 Antigonish Safety Review. Dartmouth, NS

Bond, W.K., K.W. Cox, T. Heberlein, E.W. Manning, D.R. Witty, and D.A. Young. 1992. Wetland Evaluation Guide. North American Wetlands Conservation Council (Canada), Issues Paper, No. 1992-1

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002. Canadian Species at Risk

Erskine, A.J. 1992. Atlas of Breeding Birds of the Maritime Provinces. Nimbus Publishing and the Nova Scotia Museum, Halifax, N.S.

Fuller, S. 1998. Atlas of Rare, Threatened and Infrequent Fauna of Nova Scotia. Nova Scotia Museum of Natural History draft internal document, Halifax, N.S..

Gilhen, J. 1984. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum, Halifax, N.S

Louis Berger (Canada) Ltd. 1996. An Assessment of the Economic Impact of Upgrading the Trans Canada Highway 104 To a Four-Lane, Divided, Controlled Access Highway Through Antigonish County. Atlantic Expressway Committee, Antigonish, NS.

NSDNR (Nova Scotia Department of Natural Resources). 2002a. General Status Ranks of Wild Species in Nova Scotia. Internet Publication: http://www.gov.ns.ca/natr/wildlife/genstatus/specieslist.asp.

NSDNR (Nova Scotia Department of Natural Resources). 2002b. Species at Risk in Nova Scotia. Internet Publication: http://www.gov.ns.ca/natr/wildlife/endngrd/specieslist.htm.

Pronych and Wilson, 1993. Atlas of Rare Vascular Plants in Nova Scotia. Curatorial Report No.78. Nova Scotia Museum of Natural History, Halifax, N.S.

ACCDC (Atlantic Canada Conservation Data Centre). 2002. Species Lists and Rare Species. Internet Publication: http://www.accdc.com/info/lists/.

Scott, F.W. 1994. Provisional Annotated List of Plant and Animal Species Considered to be Rare in Nova Scotia. Nova Scotia Museum of Natural History. Halifax, N.S.

Describe other major issues relevant to a decision As discussed in the Highway 104 Antigonish Environmental Assessment Report (Sections 2.1 and 6.4), the upgrade of the Highway is necessary due to increasing traffic volumes and concerns for public safety. The Five Year (1996 to 2000) blended or combined PDO collision rates for the 12.1 km of highway within the study area are about 40% higher than the comparable five year average for all provincial 100 series highways without access control. A detailed route selection process was undertaken by NSTPW to evaluate a number of options and select one alignment based on consideration of safety, and environmental and socio-economic constraints. The selected alignment is based on this evaluation and proposes to minimize disturbance where possible; however it will impinge upon some wetlands that are unavoidable due to pre-existing development or further environmental constraints.

3.4.3.6 Overall Project Impact Rating

An overall project rating occurs when the preceding Sections (3.4.3.1 - 3.4.3.4) are examined to compare the overall significance of the wetland to that of the proposed project. This significance is identified in the rating calculation which follows.

a. **Rating Calculation**
(insert total from previous Sections (3.4.3.1 - 3.4.3.4) in boxes provided, subtract total in Section 3.4.3.4. from total of 3.4.3.1 to 3.4.3.3 and calculate overall ratings)

Current Wetland Status

3.4.3.1 Biological Rating	4	(a)
3.4.3.2 Hydrological Rating	3	(b)
3.4.3.3 Social/Cultural Rating	1	(c)

Project Status

3.4.3.4 Projected Production Change Rate	4	(d)

Overall Rating=
a+b+c minus d = e 4

Note: When a value of "U" (unknown) or "NA" (not available) occurs, then proceed to either gather that information or move directly to Stage Two Detailed Analysis to address that requirement.

b. **Overall Rating**

The equation totals the three wetland function component values (a+b+c) and subtracts the new project production benefits value (d). The result is an overall rating (e) which represents the value of the wetland in relation to the benefits of the proposed project.

- Maximum possible value: 19
- Minimum possible value: 1
- Where overall rating is equal to or greater than 13, project rejection (or relocation) should be recommended.
- Where overall rating is equal to or less than 3, project approval should be recommended.
- Where overall rating is between 4 and 12 inclusive, project should be referred to Stage Two Detailed Analysis.

Recommendations

- ☐ (a) reject project
- ☐ (b) refer to Stage Two Detailed Analysis
- ☐ (c) approve without conditions
- ☒ (d) approve with conditions

(List necessary mitigative measures and measures to retain/enhance wetland functions of value to society in (e))

(e) mitigative measures 1) Construct wetland habitat along the edge of Wetland 12 to replace the 0.75 ha of habitat lost at this wetland. 2) Salvage wetland soils from disturbed portion of wetland to aid in rapid re-establishment of native plant communities in reconstructed wetland. 3) Test salvaged wetland soil to ensure that it will not release stored contaminants 4) Ensure that the hydrology of the wetland is maintained through proper culvert placement. 5) Implement erosion and sediment control measures to minimize sedimentation of wetland. 6) Minimize the area of wetland habitat lost or disturbed as a result of highway construction.

(f) reason for recommendation (note: outline by project benefits and important wetland functions/values lost or reduced do not simply report the number calculated)

The project will provide economic benefits to the local area as a result of construction activity and will improve public safety. The wetland survey and a review of the existing literature indicates that the wetland has relatively little value as wildlife habitat and as habitat for rare or endangered species. The wetland has no known social/cultural attributes. All merchantable timber in the wetland was harvested in the recent past. The wetland plays a moderate role in regulation of surface water flow. The wetland can be expected to augment stream flow during low flow periods and would help to ameliorate flood conditions by slowing the flow of flood waters. This function is not expected to be significantly altered since only approximately 10.3 % of the total area of wetland habitat will be infilled during construction resulting in the loss of wildlife habitat.

Evaluator's Signature **Date**

If referred to Stage Two Detailed analysis, outline particular project impacts or wetland functions/values that may be worthy of special attention.

CONCLUSION OF STAGE ONE "GENERAL ANALYSIS"

4.0 Nova Scotia Department of the Environment and Labour Ten Step Wetland Evaluations

This report outlines the results of wetland evaluations conducted for 15 wetlands less than 2 ha in size found within the proposed Highway 104 Antigonish By-pass. The wetland field surveys were conducted between August 20 and 23, 2002 with additional information collected during the period from June 18 to 19, 2002.

4.1 Wetland 2

Wetland Type:	Wetland complex composed of tall shrub basin swamp and basin marsh
Size:	0.42 ha.
Dominant Vegetation:	Tall shrub basin swamp
Trees:	*Picea glauca* 5%
Shrubs:	*Alnus incana* 70%
Ground Vegetation:	*Impatiens capensis* 20%, *Osmunda cinnamomea* 15%, *Onoclea sensibilis* 10 %, *Glyceria striata* 7%, *Aster puniceus* 3%.
Dominant Vegetation	Basin marsh
Trees:	None
Shrubs:	*Alnus incana* 5%
Ground Vegetation:	*Typha latifolia* 40, *Onoclea sensibilis* 30, *Thelypteris palustris* 15, *Solidago canadensis* 7%, *Cicuta bulbifera* 5%.
Vascular plant list:	See Table I2. One uncommon vascular plant species, *Asclepias incarnata* present. *Asclepias incarnata* is listed as S3 by ACCDC. Nova Scotia population considered to be secure by NSDNR.
Wildlife:	No rare or sensitive species present.
Birds:	Red-breasted Nuthatch, Ovenbird, Swamp Sparrow, and American Goldfinch
Mammals:	Racoon and White-tailed Deer
Herpetiles:	Northern Spring Peeper
Hydrology:	A small wetland located near the headwaters of a small brook. Appears to be a groundwater discharge site.
Anthropogenic uses:	None noted.
Comments:	Wetland is surrounded by roads. Dry ephemeral pool present.

4.1.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score (a wetland evaluation system used to determine the value of wetlands as wildlife habitat) is available for the wetland. During the field survey all species of bird, mammal, reptile and amphibian detected within the wetland were recorded. Wildlife species were detected on the basis of visual sightings, vocalizations, tracks, feces, skeletal remains, and distinctive spoor such as characteristic bite marks or dens.

Four species of bird were recorded in or near the wetland including Red-breasted Nuthatch, Ovenbird, Swamp Sparrow and American Goldfinch. It is likely that Swamp Sparrows nest in the wetland while the other three species may forage there. Mammals noted in the wetland included racoon and white-tailed deer. No reptile species were detected during the survey and one amphibian, the northern spring peeper, was found. The ephemeral pool in the wetland probably provides suitable breeding habitat for northern spring peepers and wood frogs. The value of the wetland as wildlife habitat is limited due to the small size of the wetland, its close proximity to houses and the fact that it is located in a small habitat fragment created by the confluence of three roads.

4.1.2 Step 2 Evaluate for Rare and Endangered Species

None of the bird or mammal species recorded in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002, NSDNR 2002a, NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 74 species (Table I2) were found in the wetland, none of which are considered to be a rare or endangered species in Canada (COSEWIC 2002) or Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b). One of the species, purple milkweed (*Asclepias incarnata*), is considered to be uncommon in Nova Scotia by the Atlantic Canada Conservation Data Centre (ACCDC)(ACCDC 2002). ACCDC classes purple milkweed as an S3 species which indicates that there are between 21 and 100 records of the species in the province and the species is found within a restricted range. The Nova Scotia Department of Natural Resources (NSDNR) general status list of vascular plants classes purple milkweed as a green species indicating that the population of this species in Nova Scotia is secure (NSDNR 2002a). Purple milkweed is typically found growing in wet or rocky thickets generally near a stream or lakeshore. At this location it was found at the boundary of the tall shrub basin swamp and basin marsh habitats near the edge of an ephemeral pool. Approximately 500 purple milkweed plants were found at this site.

4.1.3 Step 3 Evaluate Groundwater Recharge Potential

The wetland appears to be a groundwater discharge site and therefore has little or no groundwater recharge potential.

4.1.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

Swamps can contribute to the slowing of flood waters reducing peak flood heights and stretching out the high flow period over a longer period of time. This wetland may also help to regulate surface water flow by slowly releasing stored water during low flow periods thereby augmenting stream flow. Given the small size of the wetland it is not believed that this wetland would play a significant role in local surface flow regulation.

4.1.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production and has no potential to be used for agricultural production.

4.1.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

The wetland receives surface water drainage from two of the roads which surround it. The wetland may help to settle out particulates washed from the roads and road ditches. It may also absorb contaminants such as metals and hydrocarbons washed from the surfaces of the roads by precipitation. Given the small size of the wetland, this function is not rated as significant.

4.1.7 Step 7 Evaluate the Potential for Peat Development

The wetland has developed on mineral soil and contains no peat deposits.

4.1.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All issues have been addressed.

4.1.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.1.10 Step 10 Summary of Wetland Evaluation

Overall, this wetland is considered to be of moderate value. It is small and has limited value as wildlife habitat due to its small size and proximity to homes and several busy roads. However, it does provide habitat for a relatively large population of a vascular plant species (purple milkweed) which is considered to be uncommon in Nova Scotia. Although there are relatively few records of this species in Nova Scotia its population is considered to be secure. The wetland may play a small role in improving the quality of the road run-off which enters it by filtering out particulates and contaminants such as metals and hydrocarbons. It may also play a small role in surface water flow regulation. The wetland has no potential for agricultural production or peat development.

4.2 Wetland 3

Wetland Type:	Wetland complex composed of coniferous treed basin swamp and tall shrub basin swamp
Size:	0.95 ha.
Dominant Vegetation:	Coniferous treed basin swamp
Trees:	*Picea mariana* 15%, *Larix laricina* 7%, *Acer rubrum* 5%
Shrubs:	*Rubus hispidus* 15 %, *Spiraea alba* 7 %, *Alnus incana* 5%, *Nemopanthus mucronata* 2%, *Ilex verticillata* 2%
Ground Vegetation:	*Sphagnum spp.* 80%, *Carex echinata* 25%, *Eriophorum virginicum* 7 %, *Lysimachia terestris* 5 %, *Triadenum fraseri* 4 %, *Aster umbellatus* 2 %
Dominant Vegetation:	Tall shrub basin swamp
Trees:	*Picea mariana* <1 %, *Larix laricina* <1 %
Shrubs:	*Alnus incana* 60%, *Ilex verticillata* 20 %
Ground Vegetation:	*Sphagnum spp.* 30%, *Calamagrostis canadensis* 25 %, *Lycopus uniflorus* 10 %, *Glyceria canadensis* 10 %, *moss sp.* 10 %, *Osmunda cinnamomea* 5 %, *Smilacina trifolia* 5 %, *Galium sp.* 4 %
Vascular plant list:	See Table I2.
Wildlife:	No rare or sensitive species encountered.
Birds:	Common Grackle, American Goldfinch
Mammals:	White-tailed Deer
Herpetiles:	None
Hydrology:	Basin swamp with no inflow and poorly developed outflow. Headwater of tributary to West River. Probable groundwater discharge site.
Anthropogenic uses:	Some timber harvesting has occurred around the margins of the wetland.
Comments:	None

4.2.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score (a wetland evaluation system used to determine the value of wetlands as wildlife habitat) is available for the wetland. During the field survey all species of bird, mammal, reptile and amphibian detected within and immediately adjacent to the wetland were recorded. Wildlife species were detected on the basis of visual sightings, vocalizations, tracks, feces, skeletal remains, and distinctive spoor such as characteristic bite marks or dens.

Common Grackle and American Goldfinch were the only bird species observed during the field survey. The wetland undoubtedly supports a larger variety of bird species than encountered during the survey. The wetland supports an open canopied coniferous forest and an alder swamp which would provide habitat for a variety of bird species including White-throated Sparrow, Dark-eyed Junco, Hermit Thrush, American Robin, Alder Flycatcher, Yellow-bellied Flycatcher, Common Yellowthroat, and Blue-headed Vireo. There is no open water present within or near the wetland so it is not expected to provide valuable waterfowl habitat. White-tailed deer was the only mammal species detected in the wetland and no reptiles or amphibians were recorded. Mammal species expected to regularly use the wetland would include coyote, racoon, red squirrel, varying hare, red-back vole, deer mouse, woodland jumping mouse, short-tailed shrew, and common shrew. Reptiles and amphibians expected to use the wetland would include maritime garter snake, wood frog, American toad, yellow-spotted salamander, and red-back salamander. The results of the field survey suggest that the wetland is unlikely to provide significant wildlife habitat. Coniferous treed swamps and tall shrub swamps are common in the area so this particular wetland does not provide a unique habitat type. In addition, the small size of the wetland limits its value as wildlife habitat.

4.2.2 Step 2 Evaluate for Rare and Endangered Species

None of the bird, mammal or amphibian species recorded in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 49 species (Table I2) were found in the wetland, none of which is considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002).

4.2.3 Step 3 Evaluate Groundwater Recharge Potential

The wetland is characterized by the presence of an outflow stream but no inflow stream. This would suggest that the wetland is a groundwater discharge site rather than a groundwater recharge site.

4.2.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

The wetland can be expected to contribute to augmentation of stream flow during low flow periods and may help to attenuate flood conditions by storing and slowing the flow of water through the wetland. However, given the small size of the wetland this contribution is not significant. The proposed highway will result in the infilling of approximately 12 % of the wetland. The surface water flow regulation function of the wetland will not be completely lost as a result of construction and operation of the highway.

4.2.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production and has no potential to be used for agricultural production.

4.2.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

There is currently no development upstream of the wetland. As such the wetland does not provide a water treatment service.

4.2.7 Step 7 Evaluate the Potential for Peat Development

The substrate of the wetland is mineral soil rather than peat, consequently, there is no potential for peat harvesting.

4.2.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.2.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.2.10 Step 10 Summary of Wetland Evaluation

Overall, this wetland is not considered to be significant. It is small and does not provide unique habitat for plants or animals. This wetland has limited value as wildlife habitat due to its small size and the fact that it is composed of habitat types which are common in the area. No rare or endangered species were encountered in the wetland. The wetland has no potential for agricultural production or peat development and plays no significant role in the hydrology of the area.

4.3 Wetland 4

Wetland Type: Tall shrub basin swamp

Size: 0.71 ha.

Dominant Vegetation:

Trees: *Acer rubrum* 10%, *Picea glauca* 5%

Shrubs: *Alnus incana* 60 %, *Rubus hispidus* 20 %, *Ilex verticillata* 10 %.

Ground Vegetation: *Sphagnum* spp. 70 %, *Osmunda cinnamomea* 30 %, *Iris versicolor* 8 %, *Osmunda regalis* 5 %, *Carex trisperma* 2 %.

Vascular plant list: See Table I2. No rare species encountered.

Wildlife: No rare or sensitive species encountered.

Birds: Black-capped Chickadee, Cedar Waxwing.

Mammals: White-tailed Deer, Racoon, Striped Skunk, Varying Hare.

Herpetiles: None

Hydrology: Basin swamp at the headwater of a small stream. Probable groundwater discharge area.

Anthropogenic uses: Timber harvesting has occurred in the area surrounding the wetland.

Comments: None

4.3.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score is available for the wetland. Wildlife species recorded from the wetland during the field survey included Black-capped Chickadee, Cedar Waxwing, white-tailed deer, racoon, striped skunk, and varying hare. The tall shrub cover in the wetland is similar in structure and species composition to alder thickets and young deciduous forest habitat present in the area surrounding the wetland.

The wetland does not provide significant wildlife habitat. Tall shrub basin swamp is the most abundant wetland type in the area around Antigonish so this wetland does not provide a unique habitat type. Wildlife species present in the wetland are also found in adjacent young deciduous woodlands and alder thickets. In addition, the small size of the wetland also limits its value as wildlife habitat.

4.3.2 Step 2 Evaluate for Rare and Endangered Species

None of the bird, mammal or amphibian species recorded in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 44 species (Table I2) were found in the wetland, none of which is considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002).

4.3.3 Step 3 Evaluate Groundwater Recharge Potential

This wetland forms the headwater of a small stream suggesting that it is a groundwater discharge site.

4.3.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

The wetland has some potential to regulate surface water flow, however, the significance of this function in relation to other wetlands is low due to the small size of the wetland. Approximately 38 % of the wetland will be infilled as a result of highway construction so this wetland function will be reduced but not lost.

4.3.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production and has no potential to be used for agricultural production.

4.3.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

This wetland currently provides no function in water treatment due to lack of up slope sources of contaminated water. Agricultural land is located to the south of the wetland, however, all of the drainage from the fields drains away from the wetland.

4.3.7 Step 7 Evaluate the Potential for Peat Development

There is no peat present in this wetland, therefore, there is no potential for peat development.

4.3.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.3.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.3.10 Step 10 Summary of Wetland Evaluation

Overall, this wetland is not considered to be significant. It is small and does not provide unique habitat for plants or animals. This wetland has limited value as wildlife habitat due to its small size. No rare or endangered species were encountered in the wetland. The wetland has no potential for agricultural production or peat development nor does it play a significant role in the hydrology of the area.

4.4 Wetland 7

Wetland Type:	Tall shrub basin swamp
Size:	0.09 ha.
Dominant Vegetation:	
Trees:	None
Shrubs:	*Alnus incana* 70 %, *Ilex verticillata* <1 %, *Picea glauca* <1 %
Ground Vegetation:	*Rubus pubescens* 17 %, *Sphagnum* spp. 15 %, *Osmunda cinnamomea* 10 %, *Glyceria striata* 10 %, *Onoclea sensibilis* 8 %, *Poa palustris* 7 %, *Calamagrostis canadensis* 5 %.
Vascular plant list:	See Table I2. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Ruffed Grouse, American Goldfinch, Red-eyed Vireo, Black-and-white Warbler, Cedar Waxwing
Mammals:	White-tailed Deer
Herpetiles:	None encountered.
Hydrology:	The wetland receives surface water flow from a hay field to the west. This drainage appears to occur intermittently after precipitation events. Water discharges from the wetland into a small tributary of the West River. No surface water was present at the time of the field surveys (June 18 and August 20). Wetland does not appear to be a groundwater recharge site.
Anthropogenic uses:	None noted.
Comments:	None

4.4.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland does not provide significant wildlife habitat. The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score is available for the wetland. Wildlife species recorded from the wetland during the field survey included Ruffed Grouse, American Goldfinch, Red-eyed Vireo, Black-and-white Warbler, Cedar Waxwing, and white-tailed deer. No reptiles or amphibians were found during the survey. The tall shrub basin swamp habitat present in the wetland is similar in structure to the alder thickets and early successional woodlands found in the area surrounding the wetland. The wildlife species present in the wetland are also typically found in the surrounding upland habitats. In addition, the small size of the wetland also limits its value as wildlife habitat.

4.4.2 Step 2 Evaluate for Rare and Endangered Species

None of the wildlife species recorded in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 46 species (Table I2) were found in the wetland, none of which is considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002).

4.4.3 Step 3 Evaluate Groundwater Recharge Potential

The wetland does not appear to be a groundwater recharge site. Water enters the wetland through a surface water inflow channel and exits through an outflow channel. Areas of the wetland up slope of the drainage channel are saturated suggesting that groundwater discharges from the wetland.

4.4.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

This wetland is located in a shallow basin on the flank of a low hill. The wetland receives surface water drainage through a small channel which collects surface water flow from a hay field located to the west and up slope of the wetland. Once the channel enters the wetland it becomes diffuse and is not well defined. Water from the wetland eventually discharges into the West River. At the time of the field surveys (June 18 and August 20, 2002) there was no surface water in the wetland. It appears that the wetland receives a combination of groundwater and surface water inputs with surface water inputs limited to heavy precipitation events or spring snow melt. The wetland may play a small role in surface flow regulation by augmenting stream flow between precipitation events. The wetland may also help to regulate surface flow during precipitation events by slowing the flow of water through the wetland. The significance of this function is expected to be low given the small size of the wetland.

4.4.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production.

4.4.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

This wetland may play a role in water treatment. The wetland may serve as a settling pond by slowing the flow of water which enters it. This function would be particularly useful in years when the hay field is plowed and replanted. The wetland would also aid in the immobilization of nutrients. Hay fields are typically fertilized when they are replanted and may have fertilizers such as liquid manure applied to them while they are in production. The wetland could help to reduce nutrient loading to receiving waters by incorporating excess nutrients into biomass. The settling of particulates by the wetland would also help to reduce concentrations of pesticides which often adsorb to soil particles.

Once the highway is constructed, the hay field will no longer exist. As such, inputs of nutrients will cease and once the disturbed portion of the RoW is revegetated, inputs of sediment should be reduced since periodic plowing will cease. The use of pesticides will also be greatly reduced since RoW vegetation management is conducted almost entirely through mowing. Contaminants associated with the operation of the highway would include metals, hydrocarbons and road salt. Wetlands are not very effective at reducing concentrations of hydrocarbons or salt but can be effective in removing metals.

4.4.7 Step 7 Evaluate the Potential for Peat Development

There is no peat present in this wetland, therefore, there is no potential for peat development.

4.4.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.4.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.4.10 Step 10 Summary of Wetland Evaluation

The wetland is small and does not provide unique habitat for plants or animals. This wetland has limited value as wildlife habitat due to its small size. No rare or endangered species were encountered in the wetland. The wetland is not used for agriculture and has no potential for peat development. Wetland 7 may play a small role in surface water flow regulation and may improve the quality of surface water which enters it by filtering out sediment and incorporating nutrients into plant biomass. Construction of the highway is expected to result in the infilling of approximately 89 % of this wetland with the subsequent loss of these hydrological and water treatment functions. However, construction of the highway will also result in the loss of the hay field which will reduce the requirement to remove sediment, nutrients and pesticides. Operation of the highway will produce a different suite of contaminants including metals, hydrocarbons and road salt. Wetlands typically are not effective at removing either salt or hydrocarbons but can be effective at reducing metal concentrations. Loss of the hay field would therefore not make the loss of the water treatment function of the wetland entirely irrelevant.

4.5 Wetland 8

Wetland Type:	Wetland complex composed of tall shrub basin swamp and basin marsh.
Size:	0.42 ha.
Dominant Vegetation:	Tall shrub basin swamp
Trees:	*Larix laricina* 5 %, *Acer rubrum* 3 %, *Picea glauca* 1 %.
Shrubs:	*Alnus incana* 40 %, *Spiraea alba* 30 %, *Rubus hispidus* 5 %.
Ground Vegetation:	*Sphagnum* spp. 70 %, *Carex echinata* 10 %, *Solidago uliginosa* 5 %, *Dryopteris cristata* 2 %, *Viola cucculata* 1 %.
Dominant Vegetation:	Basin Marsh
Trees:	None
Shrubs:	*Alnus incana* 5 %, *Spiraea alba* 2 %.
Ground Vegetation:	*Dulichium arundinacea* 70 %, *Typha latifolia* 15 %, *Iris versicolor* 8 %, *Triadenum fraseri* 7 %, *Juncus canadensis* 5 %.
Vascular plant list:	See Table 12. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Northern Flicker, Black-capped Chickadee, Common Yellowthroat, American Goldfinch.
Mammals:	Racoon, Red Squirrel, White-tailed Deer.
Herpetiles:	Northern Spring Peeper.
Hydrology:	Basin swamp which forms the headwater for a small tributary which drains into the West River. No surface water present at time of survey. Probable groundwater discharge site.
Anthropogenic uses:	None noted.
Comments:	None.

4.5.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score is available for the wetland. During the field survey five species of bird were recorded in or near the wetland including Northern Flicker, Black-capped Chickadee, Common Yellowthroat, and American Goldfinch. Mammal species recorded in the wetland included racoon, red squirrel and white-tailed deer. Northern spring peeper was the only herpetile recorded during the survey. None of the birds and mammals associated with the wetland are obligate wetland species and are also found in upland habitats adjacent to the wetland. The wetland does not contain any open water and does not provide good waterfowl habitat. The tall shrub basin swamp which comprises most of the wetland is similar in structure to upland shrub thickets and immature forest habitat in the surrounding upland areas. In addition, the small size of the wetland limits its value as wildlife habitat. Overall, the wetland does not provide unique or particularly valuable wildlife habitat.

4.5.2 Step 2 Evaluate for Rare and Endangered Species

None of the bird or mammal species recorded in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002, NSDNR 2002a; NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 45 species (Table 12) were found in the wetland, none of which is considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002).

4.5.3 Step 3 Evaluate Groundwater Recharge Potential

The wetland is the headwater for a small tributary of the West River suggesting that it is a groundwater discharge site rather than a groundwater recharge site.

4.5.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

The wetland would play a role in surface water regulation by augmenting stream flow between precipitation events. Wetlands can also regulate surface flow by functioning like a reservoir and slowing the flow of water through a drainage system. Given the small size of the wetland this function is unlikely to be significant. Approximately 50 % of the wetland will be infilled by highway construction. Although this wetland function will not be lost as a result of highway construction, it will be substantially reduced.

4.5.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production.

4.5.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

There is currently no development in close proximity to the wetland so it does not provide a water treatment service.

4.5.7 Step 7 Evaluate the Potential for Peat Development

No peat deposits are present in the wetland.

4.5.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.5.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.5.10 Step 10 Summary of Wetland Evaluation

Overall, this wetland is not considered to be significant. It is small and does not provide unique habitat for plants or animals. This wetland has limited value as wildlife habitat due to its small size and the fact that it is composed largely of habitat similar in structure to surrounding upland forest habitats. No rare or endangered species were encountered in the wetland. The wetland has no potential for agricultural production or peat development and plays no significant role in the hydrology of the area.

4.6 Wetland 9

Wetland Type:	Tall shrub basin swamp
Size:	0.31 ha.
Dominant Vegetation:	
Trees:	*Larix laricina* 5 %, *Picea glauca* 2 %
Shrubs:	*Alnus incana* 40 %, *Spiraea alba* 25 %.
Ground Vegetation:	*Carex nigra* 20 %, *Carex echinata* 20 %, *Solidago gigantea* 18 %, *Agrostis stolonifera* 15 %, *Carex panicea* 10 %, *Iris versicolor* 5 %.
Vascular plant list:	See Table 12. No rare species encountered.
Wildlife:	One provincially uncommon species, Boreal Chickadee, recorded.
Birds:	Ruby-crowned Kinglet, Boreal Chickadee, Cedar Waxwing, Yellow-rumped Warbler, Magnolia Warbler, Common Yellowthroat, Evening Grosbeak.
Mammals:	Red Squirrel, White-tailed Deer
Herpetiles:	None noted.
Hydrology:	Basin swamp which forms the headwater for a small tributary which drains into the West River. No surface water present at time of survey. Probable groundwater discharge site.
Anthropogenic uses:	None noted.
Comments:	Wetland is located within the highway RoW but not in the footprint of the road.

4.6.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score is available for the wetland. There is no open water in the wetland suggesting that it has little value as waterfowl habitat. Seven bird species were recorded in or near the wetland including Ruby-crowned Kinglet, Boreal Chickadee, Cedar Waxwing, Yellow-rumped Warbler, Magnolia Warbler, Common Yellowthroat, and Evening Grosbeak. Red squirrel and white-tailed deer were the only mammal species detected and no reptiles or amphibians were observed. The habitat present within the wetland is similar to that found in the surrounding upland habitats and supports a similar suite of species. As such, it does not provide unique wildlife habitat.

4.6.2 Step 2 Evaluate for Rare and Endangered Species

One of the bird species recorded in the wetland, Boreal Chickadee, is classed by ACCDC as an uncommon species in Nova Scotia (ACCDC 2002). NSDNR considers the Boreal Chickadee population of Nova Scotia to be secure (NSDNR 2002a). This species was observed foraging in the wetland during the August 21 field survey but was not recorded in this area during the breeding bird surveys conducted on June 19 and 20. Boreal Chickadees typically nest in moist coniferous forest and occasionally mixedwood forest which are not present in the wetland. It is unlikely that this species would breed in the wetland nor is it likely that the wetland would provide critical habitat for Boreal Chickadee. None of the other bird or mammal species recorded in or near the wetland are considered to be rare in Nova Scotia or Canada as a whole. A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 47 species (Table 12) were found in the wetland, none of which is considered to be rare in Nova Scotia (ACCDC 2002, NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002).

4.6.3 Step 3 Evaluate Groundwater Recharge Potential

The wetland is the headwater for a small tributary of the West River suggesting that it is a groundwater discharge site rather than a groundwater recharge site.

4.6.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

The wetland would play a role in surface water regulation by augmenting stream flow between precipitation events; however, given the small size of the wetland this function is unlikely to be significant. Wetlands can also regulate surface flow by functioning like a reservoir and slowing the flow of water through a drainage system. Given the small size of the wetland it is not believed to play a significant role in local surface water flow regulation. This wetland is not located within the footprint of the proposed highway so no infilling is anticipated. As such, this wetland function is not expected to be significantly altered.

4.6.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production.

4.6.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

This wetland currently provides no function in water treatment due to lack of nearby development.

4.6.7 Step 7 Evaluate the Potential for Peat Development

No peat deposits are present in the wetland.

4.6.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.6.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.6.10 Step 10 Summary of Wetland Evaluation

Overall, this wetland is not considered to be significant. It is small and does not provide unique habitat for plants or animals. This wetland has limited value as wildlife habitat due to its small size. Boreal Chickadee, an uncommon bird species was observed in the wetland, however, the wetland does not provide suitable breeding habitat or other critical habitat functions for this species. No other species of concern were encountered in the wetland. The wetland has no potential for agricultural production or peat development nor is it expected to play a significant role in the hydrology of the area. The wetland is located within the RoW of the highway but will not be infilled as a result of highway construction since it is located outside of the footprint of the highway.

4.7 Wetland 10

Wetland Type:	Wetland complex composed of tall shrub basin swamp and basin marsh.
Size:	0.50 ha.
Dominant Vegetation:	Tall shrub stream swamp
Trees:	None
Shrubs:	*Alnus incana* 70 %, *Ilex verticillata* 5 %.
Ground Vegetation:	*Sphagnum* spp. 60%, *Onoclea sensibilis* 10 %, *Agrostis stolonifera* 7 %, *Impatiens capensis* 5 %, *Polygonum sagittat*um 2 %, *Polygonum robustius* 2 %.
Dominant Vegetation:	Stream marsh
Trees:	None
Shrubs:	None
Ground Vegetation:	*Juncus canadensis, Agrostis stolonifera, Leersia oryzoides, Eleocharis obtusa, Scirpus cyperinus.* (Cover estimates unavailable)
Vascular Plant List:	See Table I2. One uncommon species, marsh mermaid-weed (*Proserpinaca palustris*) was found in the wetland. This species is rated S3 by ACCDC and the Nova Scotia population is considered secure by NSDNR.
Wildlife:	No rare or sensitive species encountered.
Birds:	Ruffed Grouse, Rock Dove, Northern Flicker, Black-capped Chickadee, Cedar Waxwing, Common Yellowthroat, American Goldfinch.
Mammals:	Racoon, Muskrat, White-tailed Deer
Herpetiles:	Green Frog, Northern Leopard Frog, Northern Spring Peeper, probable breeding habitat for Yellow-spotted Salamander and Blue-spotted Salamander.
Hydrology:	The wetland has developed on the banks of a small stream which flows into the West River.
Anthropogenic uses:	None noted
Comments:	Wetland is located within the highway RoW but not in the footprint of the road.

4.7.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score is available for the wetland. Eight species of bird were recorded in or near the wetland during the field surveys including Ruffed Grouse, Rock Dove, Northern Flicker, Black-capped Chickadee, Cedar Waxwing, Common Yellowthroat, and American Goldfinch. Mammal species present in the wetland included muskrat, white-tailed deer and racoon. No reptiles were found in the wetland. Amphibians observed in the wetland included green frog, northern leopard frog and northern spring peeper. The wetland contains open water in the form of a relatively large pool and sluggish stream which provide good amphibian breeding habitat. The wetland is located within the RoW of the highway but is not present within the foot print of the proposed highway. Therefore, the amphibian breeding habitat present in the wetland will not be lost.

4.7.2 Step 2 Evaluate for Rare and Endangered Species

None of the bird, mammal or amphibian species observed in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 57 species (Table I2) were found in the wetland. None of these species is considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002), however, one species considered to be uncommon by the ACCDC was recorded in the wetland. This species was marsh mermaid-weed which is listed as S3S4 by ACCDC. This designation indicates that the population status of the species in Nova Scotia is not well known and ranges from uncommon to common. NSDNR (2002a) considers the Nova Scotia population to be secure. This species was found near the northern end of the wetland which is outside of the highway RoW. No construction activity is expected in the wetland so no direct habitat loss is anticipated.

4.7.3 Step 3 Evaluate Groundwater Recharge Potential

The geomorphology of the area where the wetland is found suggests that the wetland is a groundwater discharge site rather than a groundwater recharge site. The wetland is found in a valley and there is a small stream which flows through it.

4.7.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

The wetland is situated midway along the course of a small stream. It is likely that the wetland helps to supplement stream flow during low flow periods and may slow the flow of water in the stream during flood conditions. Given the small size of the wetland, it is not expected that this wetland plays a significant role in surface water flow regulation. No disturbance of the wetland is anticipated so this wetland function should not be impeded.

4.7.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production.

4.7.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

This wetland currently provides no function in water treatment due to lack of nearby development.

4.7.7 Step 7 Evaluate the Potential for Peat Development

Peat was encountered throughout the wetland and peat depth was estimated to be about one meter. Given the type of wetland in which the peat has developed it is likely that it has a high wood content and is of relatively little value as agricultural peat. The small size of the wetland would preclude development of a peat harvesting operation on the site.

4.7.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.7.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.7.10 Step 10 Summary of Wetland Evaluation

The wetland provides breeding habitat for a variety of amphibian species as well as habitat for an uncommon plant species, marsh mermaid-weed. The wetland may also play a minor role in the regulation of surface water flow. The wetland has no potential for agricultural production or peat development. No disturbance of the wetland is anticipated as a result of construction of the highway so these wetland functions should not be adversely affected. Care should be taken in the placement of culverts to prevent ponding in the wetland which could alter the habitat. In addition, the existing roadbed situated at the southern end of the wetland appears to have contributed to the development of the wetland and should be left in place to ensure that wetland hydrology is not altered.

4.8 Wetland 13

Wetland Type:	Wetland complex composed of mixedwood treed basin swamp and tall shrub basin swamp
Size:	0.94 ha.
Dominant Vegetation:	Mixedwood treed basin swamp
Trees:	*Acer rubrum* 50%, *Abies balsamea* 20 %, *Betula papyrifera* 5 %, *Fraxinus americana* 5 %.
Shrubs:	*Alnus incana* 25 %, *Cornus sericea* 5 %, *Abies balsamea* 2 %, *Ribes hirtellum* <1 %.
Ground Vegetation:	*Impatiens capensis* 30 %, *Osmunda cinnamomea* 25 %, *Rubus pubescens* 20 %, *Onoclea sensibilis* 15 %, *Aster puniceus* 5 %.
Dominant Vegetation:	Tall shrub basin swamp
Trees:	None
Shrubs:	*Alnus incana* 40 %, *Abies balsamea* 2 %.
Ground Vegetation:	*Impatiens capensis* 70 %, *Onoclea sensibilis* 15 %, *Polygonum sagittatum* 10 %, *Aster puniceus* 5 %, *Glyceria striata* 5 %.
Vascular plant list:	See Table 12. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Ruffed Grouse, Pileated Woodpecker, American Robin, White-throated Sparrow, American Goldfinch.
Mammals:	Deer Mouse, Red Squirrel, White-tailed Deer
Herpetiles:	None
Hydrology:	Basin swamp located along a small tributary to an unnamed stream which enters Antigonish Harbour. Probable groundwater discharge area.
Anthropogenic uses:	Some timber harvesting adjacent to wetland.
Comments:	None

4.8.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score is available for the wetland. Bird species observed in or near the wetland included Ruffed Grouse, Pileated Woodpecker, American Robin, White-throated Sparrow, and American Goldfinch. Mammals detected in the wetland included deer mouse, red squirrel and white-tailed deer. No herpetile species were observed during the survey. The mixedwood treed basin swamp and tall shrub basin swamp habitats which comprise the wetland are common wetland types in the area. The wetland is similar in structure and species composition to forest habitats in the surrounding terrestrial habitats. The species detected during the survey are characteristic of terrestrial habitats surrounding the wetland.

4.8.2 Step 2 Evaluate for Rare and Endangered Species

None of the bird, mammal or amphibian species observed in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 77 species (Table 12) were found in the wetland, none of which is considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002).

4.8.3 Step 3 Evaluate Groundwater Recharge Potential

The wetland is located at the edge of an intermittent stream suggesting that it is a groundwater discharge site rather than a groundwater recharge site.

4.8.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

The wetland is situated along the course of a small stream and it is likely that the wetland helps to supplement stream flow during low flow periods. Given the small size of the wetland, it is not expected that this wetland plays a significant role in surface water flow regulation. Only 0.1 % of this wetland is expected to be infilled as a result of highway construction; consequently, this wetland function should not be impaired.

4.8.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production.

4.8.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

This wetland currently provides no function in water treatment due to lack of nearby development.

4.8.7 Step 7 Evaluate the Potential for Peat Development

The wetland contains no peat deposits.

4.8.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.8.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.8.10 Step 10 Summary of Wetland Evaluation

The wetland does not provide important, unique or sensitive wildlife habitat nor does it provide habitat for rare or endangered species. Most of the forested land surrounding the wetland has been harvested. The wetland is not used for agriculture and has no potential for peat development nor does it currently play a role in water treatment. The wetland probably helps to regulate surface water flows, however, given the size and location of the wetland along the drainage course the magnitude of this function is not expected to be great.

4.9 Wetland 14

Wetland Type:	Tall shrub basin swamp
Size:	0.23 ha.
Dominant Vegetation:	Undisturbed tall shrub basin swamp
Trees:	*Abies balsamea* 3 %, *Picea glauca* 2 %.
Shrubs:	*Alnus incana* 60 %, *Ilex verticillata* 2 %, *Abies balsamea* <1 %.
Ground Vegetation:	*Onoclea sensibilis* 40 %, *Aster puniceus* 10 %, *Impatiens capensis* 8 %, *Solidago canadensis* 5 %, *Sphagnum* spp. 5 %.
Dominant Vegetation:	Heavily disturbed tall shrub basin swamp
Trees:	None
Shrubs:	*Alnus incana* <1 %, *Rubus idaeus* <1 %.
Ground Vegetation:	*Polygonum sagittatum* 40 %, *Carex lurida* 25 %, *Juncus effusus* 20 %, *Glyceria grandis* 15 %, *Scirpus microcarpus* 10 %.
Vascular plant list:	See Table I2. No rare species encountered
Wildlife:	No rare or sensitive species encountered.
Birds:	Ruffed Grouse, Black-capped Chickadee, Red-breasted Nuthatch, Cedar Waxwing, Common Grackle, Common Yellowthroat, White-throated Sparrow, American Goldfinch.
Mammals:	Racoon, Varying Hare
Herpetiles:	None observed
Hydrology:	Basin swamp located along a small tributary of the South River. Probable groundwater discharge site.
Anthropogenic uses:	Merchantable timber in the wetland has been harvested. No other uses noted.
Comments:	None

4.9.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score is available for the wetland. Eight bird species including Ruffed Grouse, Black-capped Chickadee, Red-breasted Nuthatch, Cedar Waxwing, Common Grackle, Common Yellowthroat, White-throated Sparrow, and American Goldfinch were observed in or near the wetland during the field surveys. Mammals detected in the wetland included varying hare and racoon. No herpetiles were encountered in the wetland during the survey. The habitat present in the wetland is not unique. The tall shrub basin swamp which comprises the wetland is the most common wetland habitat in the area. The wildlife species which inhabit the wetland are characteristic of the woodland habitats which surround the wetland.

4.9.2 Step 2 Evaluate for Rare and Endangered Species

None of the bird or mammal species observed in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 66 species (Table 12) were found in the wetland, none of which is considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002).

4.9.3 Step 3 Evaluate Groundwater Recharge Potential

The wetland has developed along the banks of a tributary of South River. It is more likely to be an area of groundwater discharge than an area of groundwater recharge.

4.9.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

The wetland is situated along the drainage system of a small stream which flows into the South River. It is likely that the wetland helps to supplement stream flow during low flow periods. The wetland may also play a minor role in surface flow regulation during high water periods. Water which overflows the banks of the stream during flood events can be slowed by the vegetation in the wetland thereby helping to reduce the amplitude of the flood event. Given the small size of the wetland, it is not expected that this wetland plays a significant role in surface water flow regulation. Approximately 61 % of the wetland will be infilled; consequently, this wetland function will be greatly reduced.

4.9.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production.

4.9.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

This wetland currently provides no function in water treatment due to lack of nearby development.

4.9.7 Step 7 Evaluate the Potential for Peat Development

The wetland contains no peat.

4.9.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.9.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.9.10 Step 10 Summary of Wetland Evaluation

The wetland does not provide important, unique or sensitive wildlife habitat nor does it provide habitat for rare or endangered species. The merchantable timber in the wetland has been harvested and the forested habitats around the wetland have been clear-cut. It is not used for agriculture and has no potential for peat development nor does it currently play a role in water treatment. The wetland probably helps to regulate surface water flows, however, given the size of the wetland the magnitude of this function is not expected to be great.

4.10 Wetland 15

Wetland Type:	Tall shrub stream swamp
Size:	0.57 ha.
Dominant Vegetation:	
Trees:	*Acer rubrum* 2 %, *Picea mariana* 1 %.
Shrubs:	*Alnus incana* 60 %, *Spiraea alba* <1 %.
Ground Vegetation:	*Sphagnum* spp. 35 % *Onoclea sensibilis* 30 %, *Onoclea sensibilis* 30 %, *Aster puniceus* 10 %, *Equisetum sylvaticum* 5 %, *Solidago gigantea* 5 %, *Dryopteris cristata* 3 %.
Vascular plant list:	See Table 12. One uncommon species, large purple-fringed orchid (*Platanthera grandiflora*), found in wetland. This species is classed as S3 by the ACCDC and the Nova Scotia population is considered to be secure by NSDNR.
Wildlife:	No rare or sensitive species encountered.
Birds:	Ruffed Grouse, Common Yellowthroat.
Mammals:	Red Squirrel, White-tailed Deer, Coyote.
Herpetiles:	Wood Frog, Northern Spring Peeper
Hydrology:	Stream swamp located along an intermittent stream (not shown on topographic mapping). Probable groundwater discharge site.
Anthropogenic uses:	None noted.
Comments:	None

4.10.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score is available for the wetland. Only two bird species, Ruffed Grouse and Common Yellowthroat, were noted in or near the wetland at the time of the survey. Mammals detected in the wetland included red squirrel, white-tailed deer and coyote. Northern spring peeper and wood frog were the only herpetiles detected during the survey. The intermittent stream may provide suitable breeding habitat for species such as northern spring peeper, wood frog, yellow-spotted salamander, and blue-spotted salamander which are able to nest in ephemeral water bodies. The habitat present in the wetland is not unique. The tall shrub basin swamp which comprises the wetland is the most common wetland habitat in the area.

4.10.2 Step 2 Evaluate for Rare and Endangered Species

None of the bird, mammal or herpetile species observed in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 50 species (Table 12) were found in the wetland. None of the species are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002), however, one of the species is considered by the ACCDC to be uncommon in Nova Scotia. This species is the large purple-fringed orchid (*Platanthera grandiflora*), a species typically associated with swamps and stream banks. NSDNR (2002a) considers the Nova Scotia population of this species to be secure. Large purple-fringed orchid was found near the center of the wetland outside of the RoW. Only a small area of the wetland (5 %) will be directly disturbed as a result of highway construction. This species could be indirectly affected by highway construction if the hydrology of the wetland is altered.

4.10.3 Step 3 Evaluate Groundwater Recharge Potential

The wetland has developed along the banks of an intermittent stream which would suggest that it is a groundwater discharge site.

4.10.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

The wetland is situated along the drainage system of a small intermittent stream. It is likely that the wetland helps to supplement stream flow during low flow periods and moderates surface water flow during high flow periods by acting as a reservoir and slowing the flow of water through the wetland. Given the small size of the wetland, it is not expected that this wetland plays a significant role in surface water flow regulation. Only a small portion of the wetland will be infilled during highway construction (5 %) so this wetland function should not be significantly altered.

4.10.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production.

4.10.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

This wetland currently provides no function in water treatment due to lack of nearby development.

4.10.7 Step 7 Evaluate the Potential for Peat Development

The wetland contains no peat.

4.10.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.10.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.10.10 Step 10 Summary of Wetland Evaluation

The wetland does not provide important, unique or sensitive wildlife habitat. It does provide some amphibian breeding habitat and provides habitat for an uncommon plant species, the large purple-fringed orchid. The wetland is not used for agriculture and has no potential for peat development nor does it currently play a role in water treatment. The wetland probably helps to regulate surface water flows, however, given the size of the wetland this function is not expected to be great. Construction of the highway will result in the infilling of approximately 5 % of the area of the wetland. This habitat loss should not affect the large purple-fringed orchid or significantly reduce the amount of suitable amphibian breeding habitat provided care is taken not to alter the hydrology of the wetland during construction.

4.11 Wetland 16

Wetland Type:	Coniferous treed basin swamp
Size:	0.80 ha.
Dominant Vegetation:	
Trees:	*Picea mariana* 30 %, *Larix laricina* 5 %, *Acer rubrum* 2 %.
Shrubs:	*Nemopanthus mucronata* 35 %, *Ilex verticillata* 20 %, *Alnus incana* 10 %, *Viburnum nudum* 10 %, *Gaylussacia baccata* 10 %.
Ground Vegetation:	*Sphagnum spp.* 90 %, *Smilacina trifolia* 10 %, *Gaultheria hispidula* 2 %.
Vascular plant list:	See Table I2. No rare species encountered
Wildlife:	No rare or sensitive species encountered.
Birds:	Ruffed Grouse, Red-breasted Nuthatch, Common Yellowthroat.
Mammals:	Red Squirrel, Varying Hare, White-tailed Deer.
Herpetiles:	Wood Frog, Northern Spring Peeper.
Hydrology:	Basin swamp located along a small tributary of the South River. Probable groundwater discharge site.
Anthropogenic uses:	None noted.
Comments:	None

4.11.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score is available for it. Three bird species including Ruffed Grouse, Red-breasted Nuthatch and Common Yellowthroat were observed in or near the wetland during the field surveys. Mammals detected in the wetland included red squirrel, varying hare and white-tailed deer. Wood frog and northern spring peeper were the only herpetile species recorded from the wetland. The habitat present in the wetland is similar in structure and species composition to coniferous forest stands in the area. The wildlife species which inhabit the wetland are characteristic of the woodland habitats which surround the wetland.

4.11.2 Step 2 Evaluate for Rare and Endangered Species

None of the bird or mammal species observed in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 40 species (Table I2) were found in the wetland, none of which is considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002).

4.11.3 Step 3 Evaluate Groundwater Recharge Potential

The wetland has developed at the headwaters of a small stream suggesting that it is a groundwater discharge site rather than a groundwater recharge area.

4.11.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

The wetland is situated at the headwaters of a small stream. It is likely that the wetland helps to supplement stream flow during low flow periods and help to moderate surface water flow during high flow periods. Given the small size of the wetland, it is not expected that this wetland plays a significant role in surface water flow regulation. Approximately 36 % of the wetland will be infilled resulting in a moderate reduction in this wetland function.

4.11.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production.

4.11.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

This wetland currently provides no function in water treatment due to lack of nearby development.

4.11.7 Step 7 Evaluate the Potential for Peat Development

The wetland contains peat deposits, however, given the small size of the wetland and the lack of other large peat deposits in the vicinity of the wetland, this peat deposit would be uneconomical to develop.

4.11.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.11.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.11.10 Step 10 Summary of Wetland Evaluation

The wetland does not provide important, unique or sensitive wildlife habitat nor does it provide habitat for rare or endangered species. It is not used for agriculture and has no potential for peat development nor does it currently play a role in water treatment. The wetland probably helps to regulate surface water flows, however, given the small size of the wetland the magnitude of this function is not expected to be great.

4.12 Wetland 17

Wetland Type:	Tall shrub basin swamp
Size:	0.71 ha.
Dominant Vegetation:	
Trees:	*Picea mariana* 1 %, *Betula populifolia* <1 %.
Shrubs:	*Ilex verticillata* 40 %, *Nemopanthus mucronata* 15 %, *Alnus incana* 15 %, *Spiraea alba* 15 %, *Viburnum nudum* 5 %.
Ground Vegetation:	*Sphagnum* spp. 80 %, *Smilacina trifolia* 10 %, *Osmunda cinnamomea* 2 %, *Dryopteris cristata* 1 %.
Vascular plant list:	See Table I2. One uncommon species, large purple-fringed orchid (*Platanthera grandiflora*), found in wetland. This species is classes as S3 by the ACCDC and the Nova Scotia population is considered secure by NSDNR.
Wildlife:	No rare or sensitive species encountered.
Birds:	Magnolia Warbler, Black-and-white Warbler, Common Yellowthroat, White-throated Sparrow.
Mammals:	Varying Hare, Coyote.
Herpetiles:	Maritime Garter Snake
Hydrology:	Basin swamp located along an intermittent stream. Probable groundwater discharge site.
Anthropogenic uses:	None noted.
Comments:	None

4.12.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score is available for it. Bird species found in the wetland included Magnolia Warbler, Black-and-white Warbler, Common Yellowthroat, and White-throated Sparrow. Mammals detected in the wetland included varying hare and coyote. Maritime garter snake was the only reptile species encountered and no amphibian species were detected.. The habitat present in the wetland is not unique. The tall shrub basin swamp which comprises the wetland is the most common wetland habitat in the area.

4.12.2 Step 2 Evaluate for Rare and Endangered Species

None of the bird, mammal or herpetile species observed in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 46 species (Table I2) were found in the wetland. None of the species are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002), however, one of the species is considered by the ACCDC to be uncommon in Nova Scotia. This species is the large purple-fringed orchid (*Platanthera grandiflora*), a species typically associated with swamps and stream banks. NSDNR (2002a) considers the Nova Scotia population of this species to be secure. Large purple-fringed orchid was found near the southern end of the wetland. This area is located within the highway RoW and will be infilled as a result of highway construction resulting in the loss of this population (one plant).

4.12.3 Step 3 Evaluate Groundwater Recharge Potential

The wetland has developed along an intermittent stream which would suggest that it is a groundwater discharge site.

4.12.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

The wetland is situated along the drainage system of a small intermittent stream. It is likely that the wetland helps to supplement stream flow during low flow periods and moderates stream flow during high flow periods. Given the small size of the wetland, it is not expected that this wetland plays a significant role in surface water flow regulation. Approximately 7 % of the wetland will be infilled during highway construction. As such, this wetland function is not expected to be substantially altered.

4.12.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production.

4.12.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

This wetland currently provides no function in water treatment due to lack of nearby development.

4.12.7 Step 7 Evaluate the Potential for Peat Development

The wetland contains no peat.

4.12.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.12.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.12.10 Step 10 Summary of Wetland Evaluation

The wetland does not provide important, unique or sensitive wildlife habitat. It does provide habitat for an uncommon plant species, the large purple-fringed orchid. The wetland is not used for agriculture and has no potential for peat development nor does it currently play a role in water treatment. The wetland probably helps to regulate surface water flows, however, given the size of the wetland the magnitude of this function is not expected to be great. Construction of the highway will result in the infilling of the portion of the wetland where the large purple-fringed orchid was found. The loss of the one purple-fringed orchid in this wetland will not have a significant adverse effect on the population of this species in Nova Scotia.

4.13 Wetland 18

Wetland Type:	Mixedwood treed basin swamp (clear-cut)
Size:	1.13 ha.
Dominant Vegetation:	
Trees:	*Acer rubrum* <1.
Shrubs:	*Betula populifolia* 20 %, *Gaylussacia baccata* 20 %, *Picea mariana* 18 %, *Kalmia angustifolia* 15 %, *Nemopanthus mucronata* 12 %, *Ledum groenlandicum* 10%.
Ground Vegetation:	*Sphagnum* spp. 90 %, *Osmunda cinnamomea* 10 %, *Smilacina trifolia* 7 %, *Cornus canadensis* 5 %, *Scirpus cyperinus* 5 %.
Vascular plant list:	See Table I2. No rare species encountered
Wildlife:	No rare or sensitive species encountered.
Birds:	Cedar Waxwing, White-throated Sparrow, American Goldfinch.
Mammals:	None
Herpetiles:	Eastern Smooth Green Snake.
Hydrology:	Basin swamp located along a small intermittent stream. Probable groundwater discharge site.
Anthropogenic uses:	Merchantable timber in the wetland has been harvested. No other uses noted.
Comments:	None

4.13.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score is available for the wetland. The wetland had been heavily disturbed as a result of recent timber harvesting and little wildlife activity was evident. Three bird species were present including Cedar Waxwing, White-throated Sparrow and American Goldfinch. No evidence of use of the wetland by mammals was found and eastern smooth green snake was the only herpetile species detected. The wetland does not provide unique or valuable wildlife habitat.

4.13.2 Step 2 Evaluate for Rare and Endangered Species

None of the bird or mammal species observed in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 55 species (Table I2) were found in the wetland, none of which is considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002).

4.13.3 Step 3 Evaluate Groundwater Recharge Potential

The wetland serves as the headwater for a small tributary to the South River and appears to be an area of groundwater discharge.

4.13.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

The wetland would play a role in surface water regulation by augmenting stream flow between precipitation events; however, given the small size of the wetland this function is unlikely to be significant. Wetlands can also regulate surface flow by functioning like a reservoir and slowing the flow of water through a drainage system. Given the small size of the wetland, it is not expected to play a significant role in local surface water flow regulation. About 38 % of the wetland will be infilled resulting in a moderate reduction in this wetland function.

4.13.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production.

4.13.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

This wetland currently provides no function in water treatment due to lack of nearby development.

4.13.7 Step 7 Evaluate the Potential for Peat Development

The wetland contains no peat.

4.13.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.13.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.13.10 Step 10 Summary of Wetland Evaluation

The wetland does not provide important, unique or sensitive wildlife habitat nor does it provide habitat for rare or endangered species. The merchantable timber in the wetland has been harvested and the forested habitats around the wetland have been clear-cut. It is not used for agriculture and has no potential for peat development nor does it currently play a role in water treatment. The wetland probably helps to regulate surface water flows, however, given the small size of the wetland the magnitude of this function is not expected to be great.

4.14 Wetland 19

Wetland Type:	Wetland complex composed of mixedwood treed basin swamp and tall shrub basin swamp
Size:	0.54 ha.
Dominant Vegetation:	Mixedwood treed basin swamp
Trees:	*Acer rubrum* 25 %, *Abies balsamea* 15 %, *Picea mariana* 5 %.
Shrubs:	*Alnus incana* 15 %, *Abies balsamea* 10 %.
Ground Vegetation:	*Glyceria striata* 25 %, *Rubus pubescens* 20 %, *Onoclea sensibilis* 6 %, *Equisetum sylvaticum* 5 %, *Cornus canadensis* 5 %, *Osmunda cinnamomea* 2 %.
Dominant Vegetation:	Tall shrub basin swamp
Trees:	*Picea glauca* 10 %, *Acer rubrum* 5 %, *Picea mariana* 2 %.
Shrubs:	*Alnus incana* 50 %, *Ilex verticillata* 5 %, *Rubus hispidus* 2 %.
Ground Vegetation:	*Rubus pubescens* 60 %, *Sphagnum* spp. 40 %, *Osmunda cinnamomea* 15 %, *Onoclea sensibilis* 5 %, *Solidago canadensis* 5 %.
Vascular plant list:	See Table 12. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Black-capped Chickadee, Cedar Waxwing.
Mammals:	Red Squirrel, Porcupine, Racoon
Herpetiles:	Northern Spring Peeper
Hydrology:	Basin swamp located along a small tributary to an unnamed stream. Probable groundwater discharge area.
Anthropogenic uses:	Some timber harvesting adjacent to wetland as well as blueberry fields.
Comments:	Wetland is located within the highway RoW but not in the footprint of the road.

4.14.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score is available for the wetland. Only two bird species observed in or near the wetland during the survey, Black-capped Chickadee and Cedar Waxwing. Mammals detected in the wetland included porcupine, red squirrel and racoon. Northern spring peeper was the only herpetile species observed during the survey. The mixedwood treed basin swamp and tall shrub basin swamp habitats which comprise the wetland are common wetland types in the area. The wetland is similar in structure and species composition to forest habitats in the surrounding terrestrial habitats. The species detected during the survey are characteristic of terrestrial habitats surrounding the wetland.

4.14.2 Step 2 Evaluate for Rare and Endangered Species

None of the bird, mammal or amphibian species observed in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 69 species (Table 12) were found in the wetland, none of which is considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002).

4.14.3 Step 3 Evaluate Groundwater Recharge Potential

The wetland is located at the edge of an intermittent stream suggesting that it is a groundwater discharge site rather than a groundwater recharge site.

4.14.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

The wetland is situated along the course of a small stream and it is likely that the wetland helps to supplement stream flow during low flow periods and moderates stream flow during high water periods. Given the small size of the wetland, it is not expected that this wetland plays a significant role in surface water flow regulation.

4.14.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production.

4.14.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

The wetland is located on the side of the existing Highway 104. The intermittent stream which enters the wetland runs through the ditch of the highway for approximately 300 m. Sediments scoured from the ditch as well as contaminants such as metals and road salt would enter the wetland by means of the ditch. The wetland could be expected to act as a settling pond to settle out sediments and would provide adsorptive surfaces which would help to remove metals. It is unlikely that the wetland would remove salt from the water since wetlands are typically poor at retaining sodium and chloride ions. Blueberry fields are present on the north side of the wetland. One of the hills on which these fields are situated slopes towards the wetland so some of the surface water and groundwater from the fields may flow into the wetland. Fertilizers and pesticides applied to the fields could enter the wetland in this water. Nutrients are readily taken up by plant growth and microbial activity in the wetland and pesticides can be adsorbed to organic matter and broken down by microbial activity. Pesticides and nutrients such as phosphorus which adsorb to soil particles can be filtered from run-off by the wetland. Although this wetland is located within the RoW it is outside of the footprint of the highway so this wetland function should not be adversely affected.

4.14.7 Step 7 Evaluate the Potential for Peat Development

The wetland contains no peat deposits.

4.14.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.14.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.14.10 Step 10 Summary of Wetland Evaluation

The wetland does not provide important, unique or sensitive wildlife habitat nor does it provide habitat for rare or endangered species. Much of the forested land surrounding the wetland has been harvested and some of this harvested land has been converted into blueberry fields. The wetland is not used for agriculture and has no potential for peat development. The wetland probably helps to regulate surface water flows, however, given the small size of the wetland the magnitude of this function is not expected to be great. The wetland is also expected to play a role in water treatment by removing sediment, nutrients, metals and pesticides from surface water and groundwater which enters the wetland. These functions should not be adversely affected by highway construction since the second lane will be constructed on the south side of the existing Highway 104.

4.15 Wetland 20

Wetland Type:	Mixedwood treed basin swamp
Size:	0.99 ha.
Dominant Vegetation:	
Trees:	*Picea mariana* 40 %, *Acer rubrum* 15 %, *Abies balsamea* 10 %, *Betula papyrifera* 5 %.
Shrubs:	*Ilex verticillata* 30 %, *Nemopanthus mucronata* 10 %, *Alnus incana* 15 %.
Ground Vegetation:	*Osmunda cinnamomea* 60 %, *Sphagnum* spp. 25 %, *Cornus canadensis* 5 %, *Maianthemum canadense* 2 %, *Coptis trifolia* 2 %.
Vascular plant list:	See Table I2. No rare species encountered.
Wildlife:	No rare or sensitive species encountered.
Birds:	Black-capped Chickadee, Blue Jay, American Robin, Cedar Waxwing, Evening Grosbeak, American Goldfinch.
Mammals:	Red Squirrel, White-tailed Deer, Striped Skunk, Racoon.
Herpetiles:	Green Frog, Wood Frog.
Hydrology:	Basin swamp located at headwaters of small intermittent stream. Probable groundwater discharge area.
Anthropogenic uses:	Some timber harvesting adjacent to wetland.
Comments:	Wetland not delineated on topographic mapping. Field identified and delineated using air photography.

4.15.1 Step 1 Evaluate Wildlife Habitat Potential

The wetland has not been mapped on the Wetlands Atlas for Nova Scotia so no Golet score is available for the wetland. Six bird species including Black-capped Chickadee, Blue Jay, American Robin, Cedar Waxwing, Evening Grosbeak, and American Goldfinch were observed in or near the wetland during the field surveys. Mammals detected in the wetland included red squirrel, white-tailed deer, striped skunk, and racoon. Wood frog and green frog were the only herpetile species recorded from the wetland. The habitat present in the wetland is similar in structure and species composition to mixedwood forest stands in the area. The wildlife species which inhabit the wetland are characteristic of the woodland habitats which surround the wetland. Ephemeral pools in the wetland probably provide breeding habitat for early nesting amphibian species such as wood frog, northern spring peeper, yellow-spotted salamander, and blue-spotted salamander.

4.15.2 Step 2 Evaluate for Rare and Endangered Species

None of the bird or mammal species observed in or near the wetland are considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada as a whole (COSEWIC 2002). A vegetation survey was conducted in the wetland to determine if any rare vascular plants were present. A total of 27 species (Table I2) were found in the wetland, none of which is considered to be rare in Nova Scotia (ACCDC 2002; NSDNR 2002a; NSDNR 2002b) or Canada (COSEWIC 2002).

4.15.3 Step 3 Evaluate Groundwater Recharge Potential

The wetland has developed at the headwaters of a small stream suggesting that it is a groundwater discharge site rather than a groundwater recharge area.

4.15.4 Step 4 Evaluate the Role of the Wetland in Surface Flow Regulation

The wetland is situated at the headwaters of a small stream. It is likely that the wetland helps to supplement stream flow during low flow periods and moderates stream flow during high flow periods. Given the small size of the wetland, it is not expected that this wetland plays a significant role in surface water flow regulation. Almost all of the wetland will infilled as a result of construction of the highway; consequently, this wetland function will be lost.

4.15.5 Step 5 Evaluate the Agricultural use of the Wetland

The wetland is not used for agricultural production.

4.15.6 Step 6 Evaluate the Potential Role of the Wetland in Water Treatment.

This wetland currently provides no function in water treatment due to lack of nearby development.

4.15.7 Step 7 Evaluate the Potential for Peat Development

The wetland contains no peat deposits.

4.15.8 Step 8 Have You Addressed all Potential Issues with the Wetland Proposal?

All potential issues have been addressed.

4.15.9 Step 9 Address Additional Concerns

There are no additional concerns.

4.15.10 Step 10 Summary of Wetland Evaluation

The wetland does not provide important, unique or sensitive wildlife habitat nor does it provide habitat for rare or endangered species. It is not used for agriculture and has no potential for peat development nor does it currently play a role in water treatment. The wetland probably helps to regulate surface water flows, however, given the size and location of the wetland along the drainage course the magnitude of this function is not expected to be great.

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APPENDIX J

ECONOMIC IMPACTS OF HIGHWAY BYPASS DEVELOPMENT ON COMMUNITIES

PROJECT NO. NSD16949

FINAL REPORT TO

DEPARTMENT OF TRANSPORTATION AND PUBLIC WORKS
PROVINCE OF NOVA SCOTIA

ON

ECONOMIC IMPACTS OF HIGHWAY BYPASS DEVELOPMENT ON COMMUNITIES

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1.0 INTRODUCTION

Stakeholders within the Town of Antigonish, Nova Scotia, have expressed concern over the potential *economic* impacts associated with the proposed improvements to Highway 104 near Antigonish (the Project). In general, there is a perception by some that the proposed new highway realignment, bypassing the town, will threaten the economic health of the community.

The construction of a highway bypass can be expected to create a certain level of stress and controversy within the affected community. This is most often associated with concerns that local businesses, which are dependent on "drive-through" traffic, will be adversely affected. There is a body of literature devoted to the subject, which can further inform many of the issues and increase the level of confidence in the predicted economic impacts as discussed in the environmental assessment (EA) report prepared for the Project by Jacques Whitford for the Nova Scotia Department of Transportation and Public Works. There is also some information available on the past experience with similar projects in the Maritimes.

2.0 SCOPE AND METHODOLOGY OF STUDY

A study on the economic impacts of highway bypass development was conducted in order to bring a higher level of confidence regarding the predicted impacts on the Town of Antigonish of the proposed Highway 104 improvements. This desktop study was in addition to the scope of work required for the EA, as determined by the federal and provincial regulators, and provides supplemental information to support the conclusions of the EA.

The study relied on the evidence provided in the published literature, and on information offered by key informants. Review of the information available focused on identifying the associated changes in economic development from similar projects and changes in the levels and types of economic activity. Research primarily relied on published literature that reviewed the evidence from a number of case studies. The key informants included individuals within provincial transportation departments, economic development agencies, and municipal governments in the Maritimes. The study did not canvass all Maritime jurisdictions, but focussed efforts on those regions and communities that may have relatively recently been affected by a highway bypass development. Specifically, the organisations contacted for information included:

- Colchester Regional Development Agency;
- Cumberland Regional Development Agency;
- Halifax Regional Development Authority;
- Kings Community Economic Development Agency;
- Municipality of the County of Cumberland;
- Nova Scotia Association of Regional Development Authorities;
- Nova Scotia Department of Economic Development;
- Wentworth Community Development Council;
- Town of Amherst;
- New Brunswick Department of Transportation, Planning Division;
- New Brunswick Department of Transportation, Edmundston District 6;
- New Brunswick Department of Transportation, Fredericton District 5;
- New Brunswick Department of Transportation, Moncton District 3;
- New Brunswick Department of Transportation, Saint John District 4; and
- Prince Edward Island Transportation and Public Works.

The interviews with the key informants followed a semi-structured interview guide. This guide was used to ensure that a consistent set of questions was covered during discussions, yet allow for a flexible exploration of ideas and information. Effects of highway bypasses may be positive or negative, as well as short-term or long-term. The questions were designed in a way to differentiate the short-term effects from the long-term effects, as well as to differentiate bypass impacts from other impacts on overall economic conditions, which may account for certain changes. The interviews were an important aspect of this research in order to verify and supplement the information gathered during the secondary information review.

The review of published information examined evidence from case studies in Canada and the United States. In reviewing the available evidence, it was important that applicability to the Hwy 104 Antigonish Project be considered. In general, the studies reviewed focused on communities of similar size to the Town of Antigonish (population approximately 4,750), with populations ranging from between 2,500 to 7,500.

It was beyond the scope of this study to collect new data or to conduct detailed quantitative analyses of the potential economic impacts associated with the upgrading of Highway 104 near the Town of Antigonish. Similarly, it should be noted that there is a breadth of economic geography literature that examines business location decisions and spatial market areas with respect to transportation infrastructure and the characteristics of the goods or services being sold. This literature is not reviewed here.

3.0 DOCUMENTED IMPACTS ON BYPASSED COMMUNITIES

3.1 Results of the Literature Review

Comer and Finchum (2001) examined economic impacts on 14 bypassed Oklahoma towns, ranging in population from 732 to 13,187. Based on an analysis of sales tax data, the impacts varied according to the nature of the business in question. In the study, three different types of businesses were identified that showed distinct levels of impact: traffic dependant businesses (such as restaurants and gas stations); traffic related businesses (such as downtown shops and professional services); and non-traffic related businesses (such as factories and mines). The conclusions of the study indicate that the size and overall economic strength of the town is a principal factor in whether or not a town suffers economically as a result of a bypass. The smaller the town, typically one with a population under 2,500, the more negative the economic impacts. In the case of medium (populations of between 2,500 and 7,500 people) and large (populations over 7,500 people) towns, it was found that where there were negative economic impacts associated with a bypass, the impacts were not as severe.

In a subsequent study, Comer and Finchum (2003) identified the impacts of highway bypasses in more rural areas using data from Oklahoma towns ranging in population from 2,500 to 25,000. The study provided insight into the long-term effects of a bypass, as most towns examined had bypasses constructed previous to 1990. Incorporating economic (income growth rate) and demographic (race, home ownership and age) variables, the study concluded that income growth rates are statistically lower in bypassed towns compared to non-bypassed towns.

Gillis and Casavant (1994) investigated the effects of bypass routes on towns in eastern Washington State and identified strategies to maximise the positive economic effects of bypass routes. The towns were agriculture-based and ranged in population from 1,475 to 11,500. The common effects of bypasses were identified, and the information was used to find viable tactics to lessen the negative effects and increase the positive outcomes of highway bypasses on small towns. Gillis and Casavant (1994) found the more dependant a town is on drive-through traffic, the more likely it is to feel negative impacts from a newly constructed bypass. However, if the town has historically been a trade centre for the region, the negative impacts are lessened. This is because downtown business districts with a well-developed local customer base are less adversely impacted by a bypass than towns without such a client base. Case studies suggest that the construction of a bypass will initially increase downtown business vacancies, but this will be followed by new uses of buildings as the community adjusts to the new client base and traffic patterns. In addition, Gillis and Casavant (1994) stressed the importance of a newly bypassed town capitalizing on traveller traffic by increasing the amount of signage along the newly constructed route.

Clapp *et al.* (2003) used 20 years of data in a study on the effects on retail sales in bypassed Iowa towns. In the study, three towns that were to be bypassed were compared with six towns that were bypassed in the 1980s and that were of comparable structure, size and distance from metropolitan centres. All the towns examined had a rural, farm-based economy. Based on the experience of the communities that were bypassed, the presence of an active economic development agency in the community and the ability of the town to attract new businesses to the area were identified as factors that helped the bypassed towns adjust to the changes and remain economically vibrant.

Thompson *et al.* (2001) examined communities in Kentucky and matched 21 bypass routes in eight counties that were bypassed with eight counties of similar demographic and economic structure that had not been bypassed. The study analysed economic data from the five years previous to the bypass and the five years after completion of the bypass to make comparisons between the matched counties. Factors that were compared included: 1) total employment growth rates; 2) retail sales growth rates; and 3) retail employment growth rates. The study found that on average, the total employment growth rates of bypassed counties five years after the bypass were 0.27% less than the counties that were not bypassed, although this was not statistically significant. It was found that retail sales growth was higher in counties before the construction of the bypass; retail services grew more slowly after the bypass. There were no statistically significant changes in retail employment growth rates. However, the study did find that the opening of a bypass did have a negative impact on retail sales.

A bypass does influence the business mix of the downtown area – the proportion of retail business in a bypassed town is smaller than that of a non-bypassed downtown area. Thompson *et al.* (2001) also found that most post-bypass businesses were new to the community, and were not relocated pre-existing businesses. Thirteen percent of government officials, media representatives and businesspeople interviewed as part of the research felt that the bypass hurt the retail and service business of the community as a whole. When asked specifically about the downtown retail and services, 52% believed that downtown business was not significantly impacted as a result of the bypass, and 37% believed that the bypass hurt downtown retail and service sales.

The overall conclusions of the review by Thompsom *et al.* (2001) study are as follows:

- The construction of a bypass has either no effect or a modest negative effect on the community;
- The opening of a bypass route reduces aggregate retail sales, but does not have a significant effect on retail employment, total employment or population levels;
- The bypass is more likely to encourage total employment growth if the bypass has partial access control, and is located close to the downtown sector;
- The presence of a bypass influences the business mix in the downtown area; and
- Many of the government officials, media representatives and business people agreed that the bypass promoted growth and improved quality of life.

Sivaramakrishnan and Kockelman (2002) analysed the impact of bypasses on 23 small and medium sized communities in Texas with a population of 2,500 to 50,000. Nineteen "control" towns were used as a comparison measure, and nine years of data were collected for each of the 42 towns in the study. Per capita sales from four industry sectors were used: retail sales sector; gasoline service station sales; sales at eating and drinking establishments; and service receipts. The results suggest that a bypass will negatively affect all four sectors examined, with the gasoline service centres feeling the largest negative effect; however, these effects depend on the magnitude of traffic being diverted from the downtown area.

Wells and Farnworth (2001) provide a comprehensive overview of highway bypass studies from over 100 towns and communities across the United States. Their findings indicate that businesses related to travel, such as restaurants and gas stations, were the most likely to be adversely affected, but to a much lesser degree than expected, since the travel related (drive-through) business actually made up a much smaller portion of business than was perceived by residents. In general, an initial decrease in business was experienced immediately after the opening of the bypass, followed by a recovery in sales once merchants adjusted to the change.

Burress (1996a, 1996b), Leong and Weisbrod (1999), Comer and Finchum (2001), Baker and Bellotti (2002), Clapp *et al.* (2003), and Wells and Farnworth (2001) all reported that the effects of a highway bypass are not as devastating as first feared by communities and that, in most cases, there is little to no significant long-term economic effects. The studies do generally report a decrease in travel-related business associated with motels, restaurants, gas stations and convenience stores. However, both Wells and Farnworth (2001) and Baker and Bellotti (2002) report that the business community tended to overstate the importance of travel-related business and, in fact, such business made up a much smaller portion of the economy than was initially perceived.

The studies reviewed agree that the strength of the town's economy before the highway bypass is of vital importance to the impacts the town will experience. The stronger the economic base of the community, the better it will fare after a bypass is constructed. Gillis and Casavant (1994) and Handy *et al.* (2001) both report that communities or towns that are, and historically have been, a regional trading centre notice less negative impacts than those that are not (*c.f.* Antigonish).

The size of the town and its business vacancy rate also act as predictors of the economic impacts a bypass may bring. The results of Wells and Farnworth (2001), Leong and Weisbrod (1999), Srinivasan and Kockelman (2002) and Comer and Finchum (2001, 2003) all indicate that smaller towns, typically with populations of less than 2,000, suffer more short and long-term negative economic impacts as a result of a bypass. The vacancy rate can also serve as an indicator in a similar manner – the higher the vacancy rate, the stronger the negative effects of a bypass on a town.

There are many other factors that contribute to a town's economic health in addition to highway routing. Wells and Farnworth (2001), Leong and Weisbrod (1999), and Clapp *et al.* (2003) all stress that factors such as the condition of the national and/or regional economy, the number of chain retail stores in the town, and the size of the local population may have more of an impact on the economy of a town when factored together, or even individually, than the introduction of a highway bypass. It has been suggested that residents of a town may confuse the impact that construction of a highway bypass has with impacts arising from other changes to the economy.

Handy *et al.* (2001) similarly concluded that these regional structural factors have a notable effect on the magnitude and nature of impacts of bypasses on communities. The overall decline of rural populations and growth of metropolitan areas, increases in the scale of stores and shopping centres in the retail industry (what has been called the "Wal-Mart effect"), and consolidation of distribution channels for gasoline were all cited as trends that explain some of the impacts commonly attributed to the construction of bypass routes (Handy *et al.* 2001).

Although the evidence implies that, overall, a highway bypass will not have significant negative long-term economic impacts on the community, several studies, including Handy *et al.* (2001), Wells and Farnworth (2001), Leong and Weisbrod (1999), Clapp *et al.* (2003) and Gillis and Casavant (1994) stress the importance of active leadership and planning. A strong and proactive political and business town council, in addition to increased signage on the new route indicating the variety of shops and services in the bypassed town, has proven to lower the short-term economic impacts the bypassed community may experience. Actions of local government that facilitate economic adjustments, such as the provision of utilities and other city services to new business locations at interchanges, helps improve longer-term economic performance (Handy *et al.* 2001).

Many studies, such as ones carried out by Squires (1997) Wells and Farnworth (2001), Leong and Weisbrod (1999), Srinivasan and Kockelman (2002), Gillis and Casavant (1994), and Baker and Bellotti (2002) discuss the positive impacts of highway bypasses. Construction has resulted in less congested and safer roads for local drivers and pedestrians. In addition, the main downtown roads are quieter from reduced truck traffic and require less maintenance and roadwork. The benefits of a highway bypass are rarely noted by those opposed to its construction, but should be considered by planners and residents alike.

Different communities experience different adjustment processes – some businesses may change ownership or relocate due to the altered traffic patterns, some may experience a downturn in sales followed by a recovery once adjustment has taken place, some may be able to remain viable with a sustained, longer-term decline in business (Gillis and Casavant 1994; Leong and Weisbrod 1999; Wells and Farnworth 2001; Clapp *et al.* 2003). Handy *et al.* (2001) found that for a number of case studies reviewed were able to use the opportunity to develop destination-based tourist attractions within the downtown business core. Rather than consisting of convenience-based services such as gasoline stations and fast-food restaurants, downtowns became centres of more specialised activity that have often capitalised on the historic character of the town to become a desired destination for tourists.

Regardless of how the adjustments take place, the findings were consistent that communities with a strong economic base adapt to these changes, and that in the long-term, any effects caused from the bypass are primarily small and relatively insignificant to the overall well-being of the community.

3.2 Evidence from the Maritimes

The research for this report was only able to locate one published report (Drolet 1990) that addresses the actual impacts that have occurred in Maritime communities subsequent to being bypassed as a result of a highway improvement project. Various environmental impact assessments predict the economic conditions a community may expect to experience, but monitoring and follow-up has not occurred. As a means of gathering more information, and creating a more complete picture specific to the Maritimes, contact was made with a number of economic development agencies in various counties in the region (see Section 2.0). The lack of information obtained from these agencies clearly demonstrated that this issue has not been formally examined. Provincial government departments, economic development agencies, and municipal governments in the Maritimes have not tracked or evaluated the impacts of bypass developments on communities.

Lacking available published reports, it was decided to focus on a single community that had been bypassed as a means to draw parallels. Wentworth, Nova Scotia, was chosen as the focus community due to the fact that it recently experienced the effects of a highway bypass (with the construction of the Cobequid Pass) and it houses a large "destination business" draw in the ski-hill. This destination attracts people to the community regardless of the particular make-up or characteristics of the community, similar to the way the university and other services can be expected to draw people, students, and business to the Town of Antigonish. Interviews with key informants from Wentworth were conducted as a way to document the effects of the highway bypass on that community.

Wentworth is a small community that does not have a large downtown core. Local employment is dominated by seasonal employment at Ski Wentworth during the winter months. Few people who live in the community are actually employed by local businesses. Of those who are, most are employed by the service industry in jobs that include ski-hill employees, gas station attendants, convenience store clerks, motel and hostel employees, and, in the summer, campground staff and park employees. Ski Wentworth is noted for being the largest economic contributor to the community. The majority of Wentworth residents reportedly commute to work in other areas.

From interviews (C. Hyslop, Pers. Comm., 2004; D. Powell, Pers. Comm., 2004), it was noted that since the town has been bypassed, there has been a decrease in the amount of money coming into the community. However, other businesses have developed to take the place of previous "drive-through" businesses, thus lessening the negative economic impacts. Ski Wentworth is the flagship business of the community, averaging 66,176 visits per year to the facility over the past seven years. In addition, Ski Wentworth has expanded and, therefore, currently employs more people than it has in the past. In addition to the destination draw of the ski hill, there is a hostel in the community that accommodates an average of 2,000 visitors to the region per year.

As a result of the decrease in the drive-through traffic from the bypass, two of three local gas stations (including one restaurant) closed. However, it must be noted that there is still a certain amount of drive through business as people use the Wentworth route to travel to their cottages throughout the year, as well as visitors who are exploring areas of the province outside of the main highway system. It was noted in interviews that the amount of drive-through business was very low in the first few years following the opening of the Cobequid Pass; however, since that time, the amount of traffic in Wentworth has steadily increased. The shopping patterns of residents is not believed to have changed since the bypass. The majority of shopping by the members of the community is done outside of the community in towns such as Truro, Tatamagouche, Pugwash, Amherst, or Springhill.

Interviewees believe the quality of life in Wentworth has improved since the construction of the bypass (C. Hyslop, Pers. Comm., 2004; D. Powell, Pers. Comm., 2004). Positive impacts cited include an increase in public safety and a reduction in traffic volumes and noise. There has been an increase in pedestrian and bicycle traffic, and wait times for drivers at intersections have been drastically reduced. A recognised negative impact noted is a deterioration of local road conditions because the roads are not maintained as well as they were when the highway was a main thoroughfare.

There were fears that the bypass would be devastating to the community and, although businesses were expecting a downturn, the initial shock of the changes over the first year worried some residents (C. Hyslop, Pers. Comm., 2004; D. Powell, Pers. Comm., 2004). However, since that time, the community has refocused its attention from drive-through traffic business to more destination-oriented business, and the economic impacts have been less severe than originally feared.

The Wentworth Community Development Council (WCDC), which was established in 1991 and includes representatives from the business community, ski hill, church and interested residents of Wentworth, took a proactive approach to managing the impacts of the bypass. They increased signage on the highway, directing visitors to their town. They have also been involved in the development of a tourist information centre, soon to be constructed at Exit 7. In addition, Wentworth has been advertised in the Nova Scotia Tourism Guide as a central and desirable place to stay while taking day trips to see many different areas of the province.

The only identified documented study of the economic impacts of bypass development on Nova Scotian communities was completed by Drolet (1990). The study examined the evidence with respect to the communities of Tatamagouche, Parrsboro, Truro, and Stewiacke. The objective was to document the advantages and disadvantages of the highway developments by looking at the effects on established trading and shopping patterns, mainstreet commercial activities, and the resident labour force. To collect the necessary information, the study primarily relied on interviews with mainstreet business people or business representatives of the areas.

Overall, Drolet (1990) concluded that the bypasses overall had negative economic impacts, the severity of which appeared to be in proportion to the community's ability to compete with other trading centres and maintain economic output, as well as the community's capacity to provide a variety of job opportunities. For communities still located near the highway bypass (*i.e.*, Stewiacke and Truro), some benefits were seen to the extent that they were able to "tie-into" the newly developed adjacent highway. Mainstreet businesses, in particular, were noted as having lost the sales that originated with the unscheduled stopovers from highway travellers. A number of mainstreet businesses either closed, were able to continue to operate with a smaller volume of business, or relocated their operations closer to the main highway (*e.g.*, a gas station moving to a highway interchange location).

However, Drolet (1990) did note that declines in business could be ameliorated. In the study, Truro most successfully adjusted to the changes. The community undertook improvements to the mainstreet and side streets and erected a tourist information centre to inform visitors to the town of the retail opportunities and services provided in the downtown district. Given the larger population served within the Truro area and the higher destination-dependent characteristic of the local economy, many businesses continued to prosper despite the loss of some sales from some stopover travellers.

4.0 SUMMARY AND CONCLUSIONS

In general, the studies reviewed focused on communities of similar size to the Town of Antigonish, with populations ranging from between 2,500 to 7,500. Various techniques were employed drawing from a broad range of data from a number of communities. The general results were largely consistent among studies. The key findings indicate that the development of a highway bypass results in short-term impacts primarily to drive through traffic-dependent businesses, but little or no significant long-term economic impacts overall. In addition, the magnitude of negative impacts is lessened with a pre-existing strong economic base within the community, or history of being a trade centre for the region, and implementation of appropriate planning and an economic development strategy.

The similarities of the towns in the reviewed studies to Antigonish lie mainly in the size (small to medium) and the more rural-based economies. Apart from the study by Comer and Finchum (2001) that noted the presence of a university in a town as providing a strong economic base, there were no other case studies that addressed this influencing factor. The main differences between the towns presented in this literature review and the Town of Antigonish are associated with geography – most towns examined are located in the Southern and Midwest United States. As a result, the federal and state programs available to these communities and government approaches to highway development may differ, which may have influenced the magnitude of the economic impacts on the communities examined. However, the consistency of the conclusions between the various studies does indicate that the results can be meaningfully applied elsewhere.

The opening of a highway bypass will have short-term economic effects on the town that is newly bypassed. These effects range in magnitude depending on many factors such as the size of the town, the structure of the economy and the characteristics of its economic "flagships", as well as the response from municipal government and economic development agencies. Certainly, the dependency of the Town of Antigonish on non-traffic related employment, including education and health sector employment, will lessen the potential short-term negative economic impacts. The relocation of Highway 104 will, undoubtedly, financially harm some local drive-through dependent businesses, while other businesses will benefit. Extrapolation of more specific conclusions from the literature, however, is not possible.

The predicted economic impacts are more fully described in Section 6.1 of the EA report. The short-term economic costs to local businesses of the project are offset by longer-term economic development opportunities and improvements in public health and safety. The current highway alignment and condition restricts expansion of businesses along the highway and poses risks to public health and safety. For the Project, it will be key to further identify economically and technically feasible mitigative measures to reduce adverse effects and enhance project benefits for stakeholders. This is best done during the design stage of the Project, and as part of ongoing project management during construction.

As noted in the EA report, possible mitigation measures include the development of strategies for appropriate signage, lighting, interchange landscaping, and the provision of tourist information services.

In addition, it is clear from the literature that a community's ability to adjust to a change in highway alignment and take economic advantage of the improvements in the transportation infrastructure is dependent, in part, on the effective implementation of a regional economic development strategy or strategic land use plan. It should be noted that patterns of economic development are affected by a complex mix of factors that influence where businesses are located and the nature of the customer base. The location and characteristics of transportation corridors is only one of the many determinants involved.

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APPENDIX K

MI'KMAW KNOWLEDGE STUDY

Mi'kmaw Knowledge Study

MI'KMAQ ENVIRONMENTAL SERVICES

Highway 104 Twinning Project New Glasgow to Aulds Cove

Prepared for the Nova Scotia Department of Transportation and Public Works
November 2004

MI'KMAW KNOWLEDGE STUDY

Highway 104 New Glasgow to Aulds Cove

Prepared for the Nova Scotia Department of Transportation and Public Works

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1.0 INTRODUCTION

1.1 Mi'kmaq Environmental Services

Mi'kmaq Environmental Services (MES) is a program operated by the Lands, Environment, and Natural Resources Directorate of the Confederacy of Mainland Mi'kmaq (CMM) that provides fee for service environmental consulting services. CMM provides advisory services to six Mi'kmaw communities in the province of Nova Scotia – the Paq'tnkek First Nation, Annapolis Valley First Nation, Bear River First Nation, Glooscap First Nation, Millbrook First Nation, and Pictou Landing First Nation.

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1.2 Project Description

Provincial Highway 104 links Amherst via Truro, New Glasgow, Antigonish, and Port Hawkesbury to Sydney. Portions of the highway have been twinned to provide a four-lane divided highway and plans are underway for further twinning and upgrading. The ultimate design standard is a four-lane divided wide median highway with grade-separated interchanges and crossings. It is intended to increase safety and accommodate increasing traffic volumes.

Twinning and upgrading is proceeding in phases. The New Glasgow to Aulds Cove section is divided into four sub-sections:

1) New Glasgow to Sutherlands River is a 20 km long, definitive alignment on the south side of the existing highway crossing Sutherlands River along the existing route;
2) Sutherlands River to Addington Forks is a non-definitive alignment with a possible southerly by-pass option between Barneys River Station and Glen Bard (33km long);
3) Antigonish area from Addington Forks to Taylor Road is a 21 km long, definitive alignment that crosses Trunk 4, West River, and Beech Hill between 300m and 600m south of the existing Highway 104. Just west of the South River structure the alignment crosses from the south to the north side of the existing Highway 104 to Taylor Rd (also known as the 'Antigonish bypass'); and
4) Taylor Rd. to Aulds Cove is a non-definitive alignment (39 km long).

2.0 DEFINITION OF TERMS

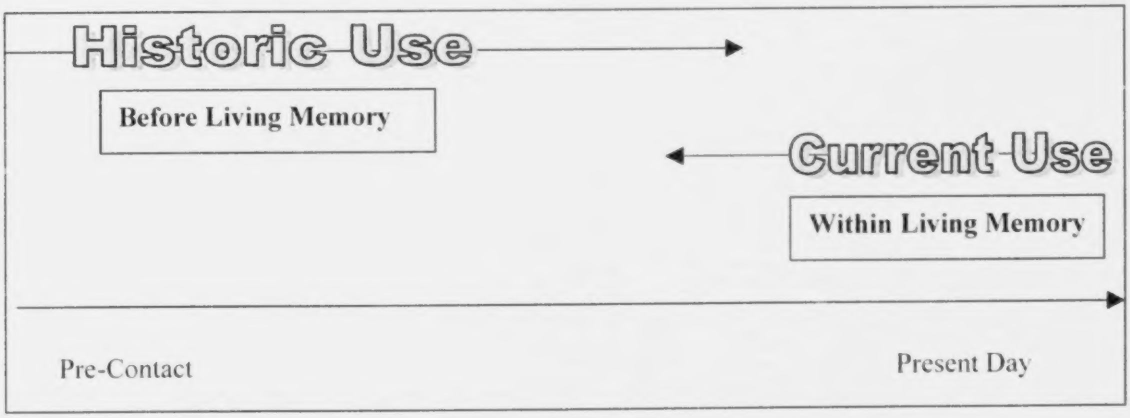
CMM/UNSI Technical Committee is chaired by Dan Christmas and comprises representatives from various Mi'kmaw organizations including the Negotiations Office. The role of the Technical Committee is to advise the Assembly of Nova Scotia Mi'kmaq Chiefs on all rights-based issues.

Living Memory is the memory of living Mi'kmaw. The period of time included in living memory varies from knowledge holder to knowledge holder. Living memory often extends to the father and grandfather of the knowledge holder and can be estimated at 3 to 4 generations.

Current Mi'kmaq Land and Resource Use occurred within living memory or is occurring at the present day (Figure 1)

Historic Mi'kmaq Land and Resource Use occurred before living memory (Figure 1)

Figure 1: Historic and Current Use Timeline



Mi'kmaw Ecological Knowledge is the collective body of knowledge which Mi'kmaq possess based on their intimate relationship with their natural surroundings, which involves exploitation, conservation and spiritual ideologies, and has been passed on from generation to generation, "*kisaku kinutemuatel mijuijij*", elder to child.

Mi'kmaq Land and Resource Use Sites are locations where Mi'kmaq land and resource use activities have taken place or are taking place at present day. These sites may or may not display physical evidence of Mi'kmaq use.

Mi'kmaw/Mi'kmaq *Mi'kmaq* means the Family and is an undeclined form. The variant form, *Mi'kmaw*, plays two grammatical roles: 1) it is the singular of Mi'kmaq and 2) it is an adjective in circumstances where it precedes a noun.

Mi'kma'ki is the Mi'kmaw homeland (Atlantic provinces and Gaspé peninsula)

Specific Land Claim arises when a First Nation alleges that the federal government has not honoured its treaties, agreements or legal responsibilities. According to federal policy, a valid specific claim exists when a First Nation can prove the government has an "outstanding lawful obligation". The Mi'kmaq are currently pursuing several specific land claims in Nova Scotia.

Comprehensive Claim is based on underlying Aboriginal Title to traditional territory that has not been dealt with by treaty or other means. Aboriginal Title to lands exists as a legal right derived from First Nations historical occupation and possession of their tribal lands. The process of negotiating the settlement of comprehensive claims, which is known as modern-day treaty making, clarifies access and ownership to land and resources. Currently, the Mi'kmaq have a comprehensive claim to all lands within the province of Nova Scotia including all inland and adjacent waters.

3.0 PURPOSE AND SCOPE OF THE MI'KMAW KNOWLEDGE STUDY

3.1 Purpose of the Mi'kmaw Knowledge Study

The purpose of the Mi'kmaw Knowledge Study is to support the integration of Mi'kmaw knowledge of use and occupation of Mi'kma'ki into development decisions via the environmental assessment process.

3.2 Scope of the Mi'kmaw Knowledge Study

The MKS includes:

1) a study of historic and current Mi'kmaq land and resource use;
2) an evaluation of the potential impacts of the Project on Mi'kmaq use and occupation and constitutionally based rights;
3) an evaluation of the significance of the potential impacts of the Project on Mi'kmaq use and occupation; and
4) recommendations to proponents and regulators that may include recommendations for mitigation measures, further study, or consultation with Mi'kmaq.

3.3 Not included in the scope of the Mi'kmaw Knowledge Study

3.3.1 Section 35 Consultation

This study is not consultation for justification of the infringement of constitutionally protected aboriginal and treaty rights. If the project involves possible infringements of Mi'kmaq constitutional rights, the MKS recommends further action.

3.3.2 Archaeological Screening and Resource Impact Assessment

The study is not an Archaeological Screening or Archaeological Resource Impact Assessment. Results presented in the study can inform and be informed by archaeological screenings and assessments.

3.3.3 Notification of Mi'kmaw individuals or communities of the Project

The study is not intended to inform or notify Mi'kmaw individuals or communities of the Project, solicit the opinions or concerns of Mi'kmaw individuals or communities on the Project, or promote the Project to Mi'kmaw individuals or communities.

4.0 METHODOLOGY

4.1 Historic Mi'kmaq Land and Resource Use

Historic Mi'kmaq land and resource use occurred before living memory. The study of historic land and resource use paints a broad portrait of Mi'kmaq use and occupation of Mi'kma'ki in centuries past.

4.1.1 Study Area

The study area is a 10km corridor on either side of the definitive route, or the existing highway where no definitive route was proposed, from New Glasgow to Aulds Cove.

4.1.2 Methods

Research was undertaken at the Nova Scotia Public Archives, Dalhousie University, Saint Mary's University, St. Francis Xavier University, King's College, and the Nova Scotia Museum. Secondary sources were used principally, although some primary sources from the Nova Scotia Museum and the Nova Scotia Public Archives were employed.

4.1.3 Limitations

Recorded documents are the primary source of information for the study of historic Mi'kmaq land and resource use. There are no recorded documents in the pre-contact period and recorded documents in the post-contact period are not comprehensive. Furthermore, existing documentation has largely been written by people of a different culture. This means that information may either not be completely accurate or may be incomplete.

4.2 Current Mi'kmaq Land and Resource Use

Current Mi'kmaq land and resource use occurred within living memory or is presently occurring. The MKS includes a study of:

1) Current Mi'kmaq land and resource use sites
2) Plants of significance to Mi'kmaq
3) Mi'kmaw communities

4.2.1 Study Areas

The study areas are described in Figure 2, Figure 3, and Figure 4.

4.2.1.1 Current Mi'kmaq Land and Resource Use Sites

The study area for current Mi'kmaq land and resource use sites is a 5 km corridor on either side of the definitive route, or existing highway where no definitive route is proposed, between New Glasgow and Aulds Cove.

4.2.1.2 Plants of Significance to Mi'kmaq

Plants of significance to Mi'kmaq were studied along the definitive routes from New Glasgow to Sutherlands River and from Addington Forks to Taylor Rd (Antigonish bypass).

4.2.1.3 Mi'kmaw Communities

The study area for Mi'kmaw communities is a 5km corridor on either side of the definitive route, or the existing highway where no definitive route is proposed, between New Glasgow and Aulds Cove.

4.2.2 Methods

4.2.2.1 Current Mi'kmaq Land and Resource Use Sites

Mi'kmaq Knowledge on current land and resource sites was gathered through a review of information collected during the Aboriginal Title Project and through oral interviews with Mi'kmaw knowledge holders.

All individuals who were interviewed signed consent forms. Knowledge was gathered in accordance with the *Mi'kmaq Ecological Knowledge Protocol* and an application to complete research was submitted to Mi'kmaw Ethics Watch.

Knowledge collected is reported in a general format only. No names or specific locations are published.

4.2.2.2 Plants of Significance to Mi'kmaq

A system of stratified random sampling was employed to identify plants present in the study areas. Surveys were conducted in July and August 2004. Information collected is reported in a general format only. The names of the species are not recorded.

4.2.2.3 Mi'kmaw Communities

All communities within the study area are recorded. If there are no communities within the study area, the nearest communities to the study area are listed.

A review of outstanding specific land claims in the study area was undertaken by The Confederacy of Mainland Mi'kmaq (CMM). Only specific land claims judged by CMM and Mi'kmaq

Environmental Services (MES) to have a potential to impact the project, or, that may be impacted by the project, are described in the report. The specific land claims described in the report may not represent all specific land claims in the study area. The report in no way limits the possibility that other specific land claims, present or future, may have an impact on the Project or may be impacted by the Project.

4.2.3 Limitations

While every attempt was made to document all available Mi'kmaw knowledge, some available Mi'kmaw knowledge may not have been captured by the knowledge gathering process. It is also recognized that over generations of cultural and political suppression, much Mi'kmaq knowledge has been irretrievably lost.

5.0 RESULTS

Results of the study are divided into two categories:

1) historic land and resource use, that is, use that occurred before living memory, and
2) current land and resource use, or use that occurred within living memory or is occurring at the present day

Land and resource use may be for hunting, burial/birth, ceremonial, gathering, or habitation purposes.

5.1 Historic Mi'kmaq Land and Resource Use

Pictou County lies on the southern coast of the Northumberland Strait, and has a length of about 80km. It extends inward to a distance of over 32km, and is bounded on the south by the Guysborough County, on the east by Antigonish county, and on the west by the Colchester county.[1] Proceeding from Pictou Harbour eastward, along the coast, we pass some small harbours known as Chance, Boat, and Little Harbours, and then meet Merigomish, formed by what is called the Big Island of Merigomish.[2] This seems to have been the original entrance to the harbour. The early French explorers in the 17th century speak of this as the entrance, but tell of it being choked with sand so that only small vessels could enter at high tide. When the first English settlers arrived, the old Indians could recollect when there was sufficient water to afford passage of their canoes.[3]

In Merigomish the same thing is noticed, particularly in the eastern portion of the harbour, between French and Barneys River. Residents have observed that the flats are widening and the water upon them becoming more shallow. The bottom too, consists of rich, soft, fine mud, extending up to the beach itself, evidently brought down by the rivers.[4] Pictou County has few lakes, compared with some of the other counties in the Province, and these are all small. The principle lakes are Eden, Brora, Sutherlands, and McDonalds Lakes.[5]

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[1] Patterson, George. **A History of the County of Pictou,** p. 9.
[2] Patterson, George. **A History of the County of Pictou,** p. 12.
[3] Patterson, George. **A History of the County of Pictou,** p. 12.

Pictou County's geological structure may be described in general terms as follows: Across the whole southern side of the county extends a range of hills of Upper Silurian formation, composed principally of beds of quartzite and slates. This band, which commences on the east at Cape Porcupine and Cape George, is about 24km broad from the east side of the county until it approaches the East River, where it suddenly bends to the south, allowing carboniferous strata to extend far up into the valley of the river. Farther west it again widens and so continues beyond the boundaries of the county.[6]

The remaining portion of the county, stretching along the straits of the Northumberland, consists of newer carboniferous rocks. Copper ores are found at Caribou River, the West River a little below Durham, the East River a few miles above the Albion Mines, and River John.[7]

The county of Antigonish (formerly named Indian Gardens) is situated in the northeast of Nova Scotia. It is nearly triangular in form, the base of the triangle being bounded by the Gulf of St. Lawrence and the Bay of St. George, while the apex is wedged between the counties of Pictou and Guysborough.[8]

Commencing at Cape George, a range of hills composed of syenite and metamorphic rocks extends westward to the upper part of the West River. Another range of similar structure, commencing at Cape Porcupine on the Strait of Canso, runs along the southern border of the county. The triangle thus formed comprises the Carboniferous system of rocks. With the exception of the hills mentioned above, the surface of the county is undulating, intersected with numerous streams and here and there diversified by lakes. From the richness in limestone and gypsum, it has that fertile calcareous soil which, combined with the rich intervals along its many streams, renders it perhaps the best fitted for agricultural purposes of any in the province.[9]

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[4] Patterson, George. **A History of the County of Pictou,** p. 16.
[5] Patterson, George. **A History of the County of Pictou,** p. 17.
[6] Patterson, George. **A History of the County of Pictou,** p. 18.
[7] Patterson, George. **A History of the County of Pictou,** p. 19.
[8] Rankin, Rev. D.J. **A History of the County of Antigonish,** p. 3.

Most of the archeological sites occur in the five estuaries along the south side of St. Georges Bay. This large U-shaped bay is connected to the Atlantic side by the Strait of Canso and opens out to Northumberland Strait on the Gulf of St. Lawrence. St. Georges Bay is a shallow, warm bay drawing its water from the Northumberland Strait. The steady current flow in the Strait generates a major clockwise circulation in the bay, but tidal flow also results in an anti-clockwise gyre. By mid-January, the bay is filled with close pack ice with ice conditions being less severe towards the east in the Strait of Canso and Chedabucto Bay.[10]

The rivers, although generally larger than those of Cape Breton, are still relatively short such that the Mi'kmaq were never more than two days canoe travel from the sea.[11] There are numerous streams and small rivers flowing into the estuaries and harbours on Northumberland Strait and St. Georges Bay—five rivers converge at Antigonish, which is sometimes translated as 'the place where the rivers meet.' To the east are several important rivers—the Guysborough, County Harbour, and St. Mary's Rivers, which discharge into elongated drowned river valleys on the Atlantic Coast. The St. Mary's river is the largest and most important salmon river. One of its branches has its headwaters in the Pictou-Antigonish uplands, the other flows for a considerable distance along the edge of the escarpment before the two branches converge 17.3km from the sea.[12]

The study area, like the rest of the province, has a mixed boreal type of vegetation. Coniferous forest predominates and consists of species such as balsam fir, white, red and black spruce, white pine, eastern hemlock and tamarack. But with changing elevation, there is a shift in species producing vegetation zones in a "layer-cake" arrangement. Evergreens are found in the lowlands and valley bottoms. Mixed woods higher up on the ridge tops and the upper slopes are deciduous hardwood sugar species—sugar maple, yellow and white birch and beech. Red maple, trembling aspen and gray birch occur in both upland and lowland stands. The hardwoods have been important historically: birch for wigwams and canoes, maple for bows, and ash for baskets, snowshoes and handles.[13]

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[9] Rankin, Rev. D.J. **A History of the County of Antigonish,** p. 3.
[10] Nash, Ronald J. **Mi'kmaq: Economics and Evolution,** p. 5.
[11] Nash, Ronald J. **Mi'kmaq: Economics and Evolution,** p. 5.
[12] Nash, Ronald J. **Mi'kmaq: Economics and Evolution,** p. 7.

5.1.1 Pre-contact Historic Mi'kmaq Land and Resource Use

The following is an outline of the different time periods in which life in Canada existed in early history, taken from Stephen A. Davis' book entitled *Micmac:*

Years Ago	Period	Tradition	Subsistence/ Settlement Patterns
Present	Historic	Micmac	Self-determination Reservations Wars against English Trade with Europeans Hunting/Gathering
400 years ago	Proto Historic	Etchmen	Beginnings of Trade Hunting/Gathering
500 years ago	Ceramic	Maritime Woodland	Hunting/Gathering Coastal, Seasonal Interior activities
2500 years ago	Late Pre-Ceramic	Broad Point Shield Archaic Maritime Archaic Laurentian Archaic	Coastal, south Interior, boreal forest Coastal, north Interior, rivers and lakes
5000 years ago	The Great Hiatus	Archeological record missing	
8000 – 11000 years ago	Paleo- Indian	Plano Clovis	Big game hunters

It is important to take note of the "The Great Hiatus" period. It refers to the time period of about 5000 years ago, where there is no archeological evidence of human habitation in Nova Scotia. Two theories have been created to explain this phenomenon. The first theory is that the environment was completely inhospitable for human habitation. The landscape was changing so rapidly that the resources that humans would have needed to maintain themselves were unreliable and thus people chose not to live in this region.[14] The second theory, and the one thought to be most likely, is that the Maritimes were occupied by people who exploited ocean resources, and thus settled along the coasts. Unfortunately for archeologists, the shorelines of 10,000 to 5,000 years ago no longer exist. Their demise was related to ongoing geological events. When the glaciers were at their heights, sea levels dropped dramatically, producing very different shorelines in the Maritimes.[15]

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[13] Nash, Ronald J. **Mi'kmaq: Economics and Evolution,** p. 7.

[14] Davis, Stephen A. **Micmac,** p. 11.

Antigonish Harbour is the largest harbour in the county, approximately 9.6km long and from 0.3 to 3.8km wide. The artifacts found in this region represent mostly isolated finds rather than small village sites. The absence of a significant village site is puzzling, although if it was at Indian Gardens, where the historic Mi'kmaq operated fish weirs, then it may have been destroyed with the growth of the Antigonish Town. Some eighty years ago, there were still birch-bark wigwams at Antigonish Landing (Indian Gardens) and sixty years ago, there were tarpaper wigwams near South River Station.[16]

In 1979, a survey revealed five sites at Pomquet Harbour, mostly on the shoreline and islands west of St. Anne's church at Summerside and containing merely a few surface finds. The only habitation site is found near the northwest corner of the main harbour, within the sight of the entrance to Pomquet Harbour. This Pomquet Point Site, BjCk-6, extends only a metre above the high tide line and covers an area of about 26 x 21 metres. There is a squarish depression at the site which troweling suggests is likely to date from the historic period. From the narrow beach came flakes, cores, a point fragment, three celts, a gouge and a circular object likely dating from the Woodland Period.[17]

Tracadie Harbour is about 3.5km long and 1.9km wide, and like Pomquet Harbour, there is a westerly extension known as Tracadie West Arm. Entrance to the harbour was formerly possible via the West Arm; the present entrance at East Tracadie was only dredged out in 1865. Thus, in earlier times, Tracadie Harbour would have been a hidden harbour behind Delorey Island and the adjacent islands connected by barrier beaches. This factor, along with being further from the open ocean and perceptibly warmer, may account for the higher density of archeological sites.[18]

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[15] Davis, Stephen A. **Micmac,** p. 11.
[16] Nash, Ronald J. **Mi'kmaq: Economics and Evolution,** p. 16.
[17] Nash, Ronald J. **Mi'kmaq: Economics and Evolution,** p. 16.
[18] Nash, Ronald J. **Mi'kmaq: Economics and Evolution,** p. 18.

In 1973, Stephen Davis recorded seven sites along the eastern and central shores of the harbour and in 1979 Ronald J. Nash surveyed Condon Cove and the interconnected islands at the mouth of the harbour, thereby adding two more sites of considerable importance. Site BjCj-8, on the west side of Condon Cove, is distributed over about 175m on the top of an elongated knoll. Artifacts are plentiful in the gardens 3-6 m above the shoreline and down to the inter-tidal zone. Most kinds of stone tools are represented including a large, thin lanceolate point found at water level. This style of point is not represented at the nearby Delorey Island Site of Woodland Age, but can be found in the largely Archaic occupation at Ingonish Island, Cape Breton. These facts, together with the apparent absence of pottery, may indicate an Archaic Period occupation at Condon Cove.[19]

The largest site discovered in the 1979 survey was the Delorey Island Site BjCj-9, which is across the harbour to the north of Condon Cove. Delorey Island is the largest of the islands at the mouth of the harbour and extends for about 1600 metres along the protected south shore. Erosion is probably greatly reduced since the site is on the inside of the island, although artifacts, especially celts, are common on the shore below the site. Some of the site may have been lost and the two tiny offshore islands may once have been connected. Finally, it should be noted that this harbour was at the location of a historic Mi'kmaq village, *Tlagatig*, meaning “the settlement”, and that on the small islands off the eastern shore are the “Indian Mounds,” a cemetery of unknown age.[20]

There has been no investigation of the separate harbour of Little Tracadie located 2.4km further east, but there are local reports of a site at Linwood. Closer to the Strait of Canso is Havre Boucher, where Erskine (1969) states that a site once existed on a great kame, prior to its destruction in the course of building the railroad.[21]

The Moodie Point Site, BkCq-20, is near the juncture of Pictou Harbour and the small Moodie Cove and is protected from the rougher waters of Northumberland

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[19] Nash, Ronald J. **Mi'kmaq: Economics and Evolution,** p. 18.
[20] Nash, Ronald J. **Mi'kmaq: Economics and Evolution,** p. 18.
[21] Nash, Ronald J. **Mi'kmaq: Economics and Evolution,** p. 18.

Strait by a bar spit some 1500m in length. The point area is good for clams, mackerel, smelt, eels, and many other resources. The site is in a sloping area at the base of a hillside and is subject to constant erosion and human activities such that artifacts can be collected on the upper beach over an east-west distance of 15 or more metres. Other than one large point, all the material seems to be late Woodland in age and thus comparable to components like Delorey Island.[22]

Delorey Island is one of three islands at the entrance to Tracadie Harbour in St. George's Bay. Across the harbour from the islands is the town of Tracadie, which is about 40km from Antigonish. These islands, formerly known as the Indian Islands, are now connected by gravel beaches, probably as a result of continued longshore currents in the bay. This coastal part of Antigonish County is a lowland area, and where farming has not yet eliminated the forest, there is a mixed deciduous/evergreen cover with white spruce being common on the Islands.[23]

On October 10, 1955, Kenneth Jopps was digging a drain on his property at Lowdens Beach near Pictou, when he discovered a burial ground. The copper-pot burial discovered that day, and the second burial site found nearby a year later, have provided a wealth of information owing to the quality and quantity of both the Native-made and European made grave gifts, and their relatively good state of preservation. In the 1980s, the date of the burials was established as being 1580-1590.[24]

The Pictou site represents an interesting variation on the Northport type of interment. Both pits contained secondary burials—in which the bodies are first laid out on scaffolding in the open air for a period of months or years, and the bones then buried in the earth. The first pit was presumed, by the grave gifts, to have contained the skeletal remains of an adult male. Only small pieces of bone were recovered. The second pit held skeletal fragments of a child, a woman, and five other adults, whose gender could not be determined.[25]

The grave's contents included 11 axes, chisels, knives, scrapers, and fleshing tools, a reed basket 6 cm long, reed and bulrush mats, about two pounds of red ochre apparently deposited in a leather pouch, a large piece of woolen blanket, thongs of rawhide and woven fabrics, a fragment of a wooden dish, and a rectangular piece of wood about 16 cm in diameter and 3 mm thick, thought to be a fragment of a breastplate. There was also a quantity of beads scattered throughout the find, ranging from about 5 mm to almost 1 cm in size, colored green, turquoise, brown, purple, and purple and white.[26]

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[22] Nash, Ronald J. **Mi'kmaq: Economics and Evolution,** p. 19.
[23] Nash, Ronald J. **Mi'kmaq: Economics and Evolution,** p. 21.
[24] Whitehead, Ruth Holmes. **Nova Scotia: The Protohistoric Period 1500-1635,** p. 49.
[25] Whitehead, Ruth Holmes. **Nova Scotia: The Protohistoric Period 1500-1635,** p. 51.

The first burial pit was excavated in 1955, and was divided into two distinct areas or sections. Section One was a circular depression of six feet (1.8 m) diameter and 3 feet (0.9 m) deep. A second depression, Section Two, lay to the north and slightly overlapped the first section. It was of the same depth, covered roughly the same area, but was irregular in shape; this second section was much less carefully prepared. Both portions had nearly vertical sidewalls. The floor of Section One was covered with twigs and small branches. Over these, there was a carefully prepared birch bark sheathing, which covered the entire floor and then reached up along the sides to a height of 45 cm from the bottom. Five layers of pelts lay above the bark on the floor. The final pelt layer lay with flesh side up and was painted red. Three intact, inverted copper kettles lay on the painted skin. Beneath each kettle was a very black layer of decayed organic material. Several grave gifts lay on the black stratum and were protected by the kettles from the earthen grave fill. These included a wooden bow, iron trade axe with handle, awls, fragments of cloth, and a glazed pottery beaker.

Section Two adjoined the first part on the northerly side. Possibly the carefully prepared portion was not large enough to receive all gifts necessitating the hasty preparation of an extension. All the kettles in the second section were mutilated; some were badly crushed by deliberate flattening under heavy pressure and the rest were slashed with an axe. Many French trade objects and some native artifacts thrown into the grave along with the kettles were scattered about in no definite order.[27]

The second burial pit was a circular excavation with a total depth of 121 cm along the northerly side and 121 cm on the southerly; the floor was level and the difference in depth was a result of the sloping surface of the ground. The sides were virtually vertical to a depth of 86 cm when they sloped inwards to make a pit bottom measuring 173 cm x 160 cm. The lowest 36 cm contained skeletal remains from either three or four bodies together with a compact mass of grave goods. In the next 38 cm were skeletal fragments from a single body together with two inverted copper kettles and stone and earthen fill. The third section, 28 cm deep, showed traces of two fires lit over the grave, evidently of a ceremonial nature.[28]

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[26] Whitehead, Ruth Holmes. **Nova Scotia: The Protohistoric Period 1500-1635**, p. 51.
[27] Whitehead, Ruth Holmes. **Nova Scotia: The Protohistoric Period 1500-1635**, p. 53.

Other artifacts that were found included: a porcupine skin, with quills still attached, a hair roach of moose neck hairs, painted with red ochre and slip-knotted at one end over sinew cordage, the cord then coiled into a tubular headdress (probably from the suspected male burial in Pit 1), and a collection of nine beaver molars and pre-molars. Five smooth round pebbles coated with red ochre, labeled "Pit A," may represent symbolically the firestones dropped into bark containers of water to bring them to a boil. Pelts included moose, deer, bear, and beaver.[29]

The known archaeological sites of Merigomish harbour comprise 18 shell-heaps, the prehistoric cemetery excavated by Patterson, a modern cemetery, and places that may be, respectively, a modern wigwam site, a burial place of "battle field", an earthwork, and workshop.[30] A single wigwam site is said to be located at Hardwood point, about three quarters of a mile north of Merigomish. The spot is among alders about 150 feet (46 m) back from the beach and about the same distance west of the east line of the Olding farm. It was probably the site of a modern Mi'kmaq Indian camp.[31]

There is a consecrated French and Indian cemetery on the high land at the south side of Big Island on the north side of Savage cove. It is approximately three kilometres northwest of Merigomish. Patterson states that the Mi'kmaq Indians used it as a cemetery until about 1837 but he gives its location at about 800 m west of a prehistoric cemetery. This cemetery was located on the farms of Mr.

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[28] Whitehead, Ruth Holmes. **Nova Scotia: The Protohistoric Period 1500-1635**, p. 55.
[29] Whitehead, Ruth Holmes. **Nova Scotia: The Protohistoric Period 1500-1635**, p. 60.
[30] Smith, Harian I. **The Archeology of Merigomish Harbour**, p. 7.
[31] Smith, Harian I. **The Archeology of Merigomish Harbour**, p. 9.

James McGlashan and Mr. Donald McGregor, the McGregor land now being owned by the son, Mr. George McGregor. Patterson claimed that it had been distributed in a search for specimens before he excavated it, and a number of stone axes and arrowheads taken away.[32]

A site at the east side of the Barneys River bridge is thought, by Mr. Wallace Copeland of Merigomish, to be a burial place or "battle field" because many bones have been ploughed up at the place.[33] A supposed earthwork, locally known as the "Boars Back", is near Barneys River. Patterson relates a tradition recorded by Silas T. Rand concerning the last war in the area, in which the Mi'kmaq of the harbour fought other Indians. The Mi'kmaq were entrenched in a blockhouse or a fort at the mouth of Barneys River. These blockhouses were constructed of logs raised up around a vault first dug in the ground. The old Indian fortifications were a sort of palisade enclosure formed of trees and stakes driven into the ground between them, with branches of trees interlaced. In times of war the women and children were always kept in such fortifications. After obtaining axes from Europeans they may have made one like the blockhouse referred to above. This supposed earthwork, however, is probably natural or made by white men, as earthworks of aboriginal origin are not known in the Maritime Provinces or nearer than Massachusetts.[34]

Many chipped points for arrows and a very great number of chippings have been found on Thomas Patton's point, now owned by Mr. R. Patterson, at Lower Barneys River. The site may have been a workshop where stone was chipped into points for arrows, knives, and scrapers.[35]

There are a number of sites on Pictou harbour, at the beaches, and at Fisher's Grant. There is a small adze made of stone from the beach at Pictou, a fragment of adze made of stone from Town gut, two adzes made of stone, one of them double bitted, from Bug Gut, East River, Pictou. In the same collection from East River are two adzes made of stone, one of them grooved on the rounded side of the head. There is also a shell-heap, which is the site of old campfires, composed of oyster, clam, and mussel shells on Ives Point, on the east side of East River.[36] Stone axes and knives were found a few hundred yards north of Indian Cross point, a little below Ives point.

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[32] Smith, Harian I. **The Archeology of Merigomish Harbour,** p. 10.
[33] Smith, Harian I. **The Archeology of Merigomish Harbour,** p. 14.
[34] Smith, Harian I. **The Archeology of Merigomish Harbour,** p. 14.
[35] Smith, Harian I. **The Archeology of Merigomish Harbour,** p. 14.

Many shell-heaps have been found in this area of study including: Quarry Island, Indian Island, Olding Island (Point Betty island), Savage Cove, Big Island, Smashem Head, Finlayson Island, Pig Island, Kerr Point, Smith Point, Barneys River, Central Ponds, Little Harbour, Ives Point, East River, Fraser Point, and Caribou Island.[37]

According to Rev. George Patterson, there is a tradition from the Mi'kmaq of conflicts between themselves and the Caniba (who are also known as Norrridgewock, Kennebec, Camba, Canaba) before European contact. The Caniba Indians are an Eastern Abenaki tribe who originate from the area around Maine. For some time there existed a state of hostility between the Canibas and the Mi'kmaq. Two parties of the former, led by two brothers, had come to Pictou and had fortified themselves in two blockhouses at Little Harbour. These blockhouses were constructed of logs, raised up around a vault first dug in the ground. The buildings were covered over, had a heavy door, and were quite a safe fortification in Indian warfare. At the mouth of Barneys River, near the site of the burying ground, the Mi'kmaq were entrenched in a similar fort. There was no fighting for some weeks, but the parties kept an eye on each other; there was no friendly intercourse between them, but there was no actual conflict.

One night a party of the Mi'kmaq went out 'torching' (catching fish by torchlight). They were watched by the Canibas, who ascertained that they did not return to their fort after they returned to the shore, but lay down on the bank about midway between the fortifications of the hostile parties. This was too powerful a temptation to be resisted. Two canoes came upon them filled with armed men. The Mi'kmaq were surprised and butchered, except two who escaped. They rushed to the water and swam for life and were hotly pursued. While passing a place where a tree had fallen over into the water, they took refuge under the tree and their pursuers missed them in the darkness. After the search was abandoned and the canoes had returned, the two men came forth from their hiding place and ran home to spread the alarm.

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[36] Smith, Harian I. **The Archeology of Merigomish Harbour,** p. 15.
[37] Smith, Harian I. **The Archeology of Merigomish Harbour,** p. 7-15.

Their dead companions had been scalped and their bodies consumed by fire. This news roused all the warriors and they resolved immediately to attack the party that had committed the outrage and avenge it. They had a small vessel lying inside the long bar that makes out at Merigomish. This was immediately emptied of its weight, drawn across the Big Island beach, and filled with men, arms, and ammunition. They then moved up to the forts of the Canibas, where it was run ashore. The party was led by a "*keenap*", a 'brave,' named Thunder, or *Caktoogow*. They ran the vessel ashore and, in his eagerness for the encounter, Caktoogow jumped into the sea, swam ashore and rushed upon the fort without waiting for his men.

Being a mighty warrior, Caktoogow could render himself invisible and invulnerable, and they fell before him. Having killed them all he piled their bodies into the building and set fire to it, serving them as they had served his friends. When all was accomplished, his wrath was appeased. Caktoogow then, at the head of his men, walked towards the other fort without any hostile display, and the Canabas chief directed his men to open the door for them and admit them in a peaceful manner. This chief had taken no part in the incident. He had disapproved of his brother's attack upon the torching party, and had endeavored to dissuade the others from it. So when Caktoogow entered the Canabas fort there was no display of hostility. After their mutual salutation, Caktoogow dryly remarked, 'Our boys have been at play over yonder.' 'Serve them right,' answered the Canabas chief, 'I told them not to do as they did. I told them it would be the death of us all.'

It was now proposed that they should make peace and live in amity for the future. A feast was made accordingly and they celebrated it together. After the eating comes the games. They tossed the *allestakum*—the Indian dice and play ball.

In all the games the Mi'kmaq got the victory. After the games were over, the Canibas chief gave the word *Novgooelnumook*, 'Now pay the stakes.' A large blanket was spread out to receive them and the Canibas stripped themselves of their ornaments and cast them in. The following articles were enumerated by the historian: epauletts, breastplates, brooches, nose rings, finger rings, a sort of large collar loaded with ornaments, more like a jacket than a collar, hair binders, garters made of silver, and hat-bands. These articles were piled in and the blanket filled so full that they could scarcely tie it. Then another was put down and filled as full. After this the Canibas returned to their own country. A lasting peace had been concluded, which has never yet been violated, and it is not likely it ever will be.[38]

5.1.2 Post-Contact Historic Mi'kmaq Land and Resource Use

When European voyagers first visited our coasts, the walrus was still found in this latitude; and with the memory of the persons still living, the seal was also in abundance. The first visitors to Pictou describe in glowing terms the size and abundance of the oysters to be found in our harbour and the shell heaps on the site of old Indian encampments.[39]

The Mi'kmaq lived mainly on the coast. Explorers and pioneer settlers found evidence of Mi'kmaw settlements on both the east and west sides of the East River estuaries, at West River, at the Big Island of Merigomish, at the mouth of Barneys River, at Middle River Point, at Cariboo, and Little Harbour. Pictou was the center of the district on Nova Scotia's north shore, those belonging to it being called "Pectougawak" (Pictonians). The Pictougawak tribe's headquarters was probably at Merigomish, and near here they buried their dead on Indian Island, a place which has religious and emotional significance to the remaining Indians who live on the federal government reservation at Pictou Landing. The river mouths on Pictou's coastline were advantageous campsites for the aboriginal inhabitants. The waters were filled with an abundant supply of shell and vertebrate fish, the water surface was filled with wild fowl, and the forests were stocked with small game, moose, and caribou.[40]

The name Pictou was supposed by many to have been a corruption of *Poictou*, the name of an old Province of France. The Mi'kmaq have a traditional story as to the name of Pictou: At one time there had been a large encampment up the West River. On one occasion they all left on their canoes on a cruise down the harbour.

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[38] Patterson, Rev. George. **A History of the County of Pictou,** p. 34.
[39] Patterson, Rev. George. **A History of the County of Pictou,** p. 20.
[40] Cameron, James M. **Pictou County's History,** p. 1.

During their short absence, the whole encampment was burned up, including the woods surrounding it. No person could tell how the fire originated. They always spoke of the event as the "*Miskeak Bucto*", or big fire, which naturally became associated with the place. When the whites came, hearing the Mi'kmaq speak of it in this way, they corrupted the name and called the whole north side of the harbour Pictou, because they could not pronounce it correctly.[41]

Of the seven divisions, Pictou was the centre of the district extending along the north shore of Nova Scotia. Merigomish however, seems to have been their headquarters. This was a favourable position for them because it was near the fishery of the Gulf, the islands abounded in wild fowl, the rivers swarmed with fish, and the woods in rear were plentifully stocked with game.[42] Their principle place of encampment was at the foot of Barneys River, on the east side, where they had some clearings on which they grew Indian corn and a few beans, at the time of English arrival. Other places such as the Big Island, some of the smaller islands in the harbour, and some of the points on the shore, were also sites of their encampments.[43]

Their burying ground, when the English settled, was near the west end of the Big Island on the south side, a short distance east of Savage Point. They used this until about forty years ago, and a number of crosses stood at this site until recently. All the Indians of the county now bury on Chapel Island or Indian Island, an island in the harbour donated to them by Governor Wentworth.[44]

The mouth of the East River is marked as the site of an Indian village. There, close to the river is a beautiful flat where the land was cleared when the English settlers arrived. When it was ploughed, various articles were turned up such as broken pieces of cookery, a gun barrel, and on one occasion a pewter basin (which was about 16 cm in diameter, with a narrow rim), and five or six tablespoons. Quite a number of stone hatchets and oyster shells have also been found. These artifacts show that the Mi'kmaq occupied this place both before and after the arrival of the Europeans.[45]

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[41] Patterson, Rev. George. **A History of the County of Pictou,** p. 23.
[42] Patterson, Rev. George. **A History of the County of Pictou,** p. 23.
[43] Patterson, Rev. George. **A History of the County of Pictou,** p. 27.
[44] Patterson, Rev. George. **A History of the County of Pictou,** p. 27.

On a point a little lower down the river was another burying place. A large iron cross about 3 m high stood here at the arrival of the English settlers. Hence the place is still known as Indian Cross Point, though the locality is known among the Mi'kmaq, as *Soogunagade*, or rotting place. Erosion is wasting away the bank, so at times human bones may be found exposed on the shore.[46]

Mr. Donald McGregor of the Big Island was ploughing a spot on his field when he turned up a human skull. Upon examination, he found a mass of decayed human bones among them a skull, transfixed by a flint arrowhead that yet remained in its place. Along with these remains were a large number of ancient implements, stone axes, flint arrowheads, etc., but none of them showing contact with Europeans. The transfixed skull, and the whole appearance of the place, plainly showed that these were the bodies of those who had fallen in some battle and had been heaped together, "in on red burial blent."[47]

The burial ground was very shallow, being no more than 30 – 40 cm deep. At the bottom there were decayed fragments of birch bark, in which, according to the custom of the ancient Mi'kmaq, the dead were laid. The shallowness of the pit also indicates that this burial took place previous to the coming of Europeans, when sharpened sticks of wood were the only instruments of digging.[48]

Upon examining the ground in the area, it was found that it was the site of an ancient cemetery, in which we found, in addition to such implements as already mentioned, bone spearheads and small copper knives. The burying ground was used by the Mi'kmaq until about forty years ago and was about half a mile further to the west. Some of the belongings seemed to indicate that they belonged to another race, a people of small size, like the Esquimaux. The Algonquin race came from the southwest is now the general opinion of American antiquarians and there are also strong reasons to believe that the Esquimaux occupied the shores of North America to a point much farther south than they now do. Charlevoix describes the Mi'kmaq in his day as maintaining a constant warfare with the Esquimaux, and the probability is that the Mi'kmaq, on first occupying this region, drove out the Esquimaux, and these remains may be the relics of their conflicts.[49]

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[45] Patterson, Rev. George. **A History of the County of Pictou,** p. 27.
[46] Patterson, Rev. George. **A History of the County of Pictou,** p. 29.
[47] Patterson, Rev. George. **A History of the County of Pictou,** p. 29.
[48] Patterson, Rev. George. **A History of the County of Pictou,** p. 30.

One curious fact was found in this cemetery that has not generally been noted in connection with Mi'kmaq customs, that is, the use of fire in some way in connection with the dead. Some of the graves give no indication of this, and in one it was possible to trace the position in which the body was laid – on its side in a crouching posture. But in other cases the remains were mixed with ashes, small pieces of charcoal, and burnt earth showing the use of fire for some unexplained purpose. In another case, a quantity of ashes with small fragments of burnt bones had been found. The whole had been carefully buried, and was probably the remains of some captive whom they had burned.[50]

The earliest settlement by Frenchmen in the County of Antigonish was about the year 1776, when a number of colonists, among them Peter Benoit and Charles Delore, settled at Tracadie. Pomquet (from the Micmac, *Pogumkek*, meaning dry sand) was settled about the same time by Louis La Mort, Cyprian Dorion, Peter Brussard, Simon Vincent, Charles Melanson, and Joseph Dorion.[51]

It is said that Captain Timothy Hierlihy was sent to recapture four or five deserted soldiers. He landed at Pictou, took an Indian guide to Merigomish, and cruised along the shore to Guysboro where he overtook the deserters. It was on this expedition that a circumstance arose which led to the settlement of the county. A boat approached the mouth of Antigonish Harbour and Captain Hierlihy observed a number of Indians running down to the shore. At this time they were very numerous and not overly friendly towards the British. Suspecting some treachery, Captain Hierlihy drew his sword and told his Indian guide that if the Indians fired a shot he would run him through. The Indian shouted to those on shore and in an instant the beach was covered with the natives who had been hiding behind stones and sandbanks. Upon seeing that the strangers were friendly, they came and welcomed them. The boat then proceeded up the harbour. It was in the month of

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[49] Patterson, Rev. George. **A History of the County of Pictou,** p. 31.
[50] Patterson, Rev. George. **A History of the County of Pictou,** p. 31.
[51] Rankin, D.J. **A History of the County of Antigonish,** p. 4.

June, and seeing the shores so beautifully wooded, Captain Hierlihy was pleased with the place and made up his mind that as soon as the war should end, he would take up a grant of land in that locality. In the autumn of 1783, the regiment was called to Halifax and disbanded. A grant of 26,600 acres (10,765 hectares) was made to Colonel Hierlihy and 88 others.[52]

On one occasion Captain Hierlihy and his men were invited by the Indians to cross the harbour to their encampment at a place called Gafford's Rock, now called Mullin's Rock, to witness an Indian dance. The invitation was accepted and all seemed to be going along well. After a time, however, Captain Hierlihy observed that the Indians were getting their guns ready and suspected that all was not right. He collected his men and they marched to their boats. The Indians, shouldering their guns, marched beside them saying "Me soldier too, me soldier too." When the boats were pushing off, their aspect became more threatening. Pointing to the other shore they said: "That your side of the water, this Indian's side, don't you come back here again." Few in number and almost unarmed, it was useless for the settlers to show any resistance. The next morning, however, Captain Hierlihy collected as strong a force of soldiers as he could muster, crossed to the Indian encampment, and began to drill his men. They went through the exercise of firing blank cartridges and gave the Indians a scare. After this they gave the settlers no further trouble.[53]

Zephaniah Williams employed an Indian named Joe Snake to guide him by the shortest route from William's Point to the Hartshorne Grant. Setting out one morning they made a blaze upon the trees as they went along. This became a guide for the travelers until a footpath became a cart road. Clearings were made along this road and houses built. The path taken by Williams and Joe Snake has become the principle street of the town of Antigonish.[54]

There is a tradition that happened just before the arrival of the Europeans between the Mi'kmaq and the Mohawk in Pictou County. The Mi'kmaq had concealed themselves in the woods on Little Caribou Island. Between this and the mainland, the passage is very narrow, not 200 yards (183 m) wide. The Mohawks had detected the hiding place of the Mi'kmaq and resolved to cross by night and attack their enemies while they were asleep. But the tide was too powerful for any man to swim across it. The Mohawks, not knowing this, had plunged in and the tide swept them away. In the morning the returning tide brought back their dead bodies, each with a tomahawk tied on his head. The Mi'kmaq coming out of their place of concealment were filled with joy at the sight of their dead foes and danced in triumph for their deliverance. At the time of the arrival of the English settlers the affair was still fresh in the memory of the Mi'kmaq and was represented as having taken place during the wars between the English and the French. The place is still named by the Mi'kmaq *Tedootkesit*, meaning the place of running to the brushes from the Mi'kmaq taking refuge in the woods.[55]

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[52] Rankin, D.J. **A History of the County of Antigonish**, p. 5.
[53] Rankin, D.J. **A History of the County of Antigonish**, p. 8.
[54] Rankin, D.J. **A History of the County of Antigonish**, p. 11.

The settlement of Pictou County by English and Gaelic speaking settlers began after French power in Nova Scotia had ceased, and with it the Indian opposition to the British. Mi'kmaq leaders in 1760 appeared before the Legislative Council in Halifax to make peace. In 1762 a proclamation was issued to prevent encroachment on Indian lands, which was a follow up to a ten-year-old statute that forbade acts of aggression against the Indians.[56]

As the settlers fanned out from Pictou, they found Indians with small plots under primitive cultivation at Middle River Point and Barneys River. These and others were purchased from the Mi'kmaq for a meager amount by the whites. The Indians' principal district, Merigomish (an Anglicized spelling and pronunciation of the Indians name for the district "Mallogomichk", meaning a hardwood grove) was taken over entirely by the whites, except two small islands.[57]

At the time of Confederation, some Indians were living on the land later called Chapel Cove, one of the smaller Indian camping places in use before the whites had arrived. It was first designated by the whites as Fisher's Grant, later known as Pictou Landing. It was recognized as Indian land by the Province of Nova Scotia and was transferred to the Dominion at Confederation in keeping with the BNA Act, which put administration of Indian Affairs within the jurisdiction of the Federal Government. Following Confederation, a number of land parcels at Pictou

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[55] Patterson, George. **A History of the County of Pictou**, p. 33.
[56] Cameron, James M. **Pictou County's History**, p. 2.
[57] Cameron, James M. **Pictou County's History**, p. 2.

Landing-Chance Harbour were acquired by the Dominion as a reserve for the Pictou Landing Indians—89 acres (36 ha) in 1874, 16 acres (6.5 ha) in 1876, etc., until the total encompassed 1158 acres (468 ha), classified by the Federal authorities as Fishers Grant Indian Reserve No. 24. Additionally, Chapel Island and Wooley Island, 30 acres (12 ha) and 5 acres (2 ha) respectively in Merigomish Harbour were set aside. In 1960 they were designated Merigomish Harbour Indian Reserve No. 31 for the use and benefit of Pictou Landing Indians.[58]

For the Indians, the white man brought disaster. In 1775 Magistrate Harris reported their number in the County to be 885. The first federal census almost a century later in 1871 reported the County's Indian population to be 125 which was a shocking decline said to have been caused by Indians lacking immunity to the white man's diseases – small pox, and tuberculosis. By 1961 the census showed the Pictou Landing Indian band had increased in the intervening ninety years to over 200. White settlements on the coast and up-river crowded them off their fishing and hunting grounds.[59] In 1722, there were 93 Mi'kmaq in Antigonish, and 45 in Pictou, in 1735, 127 in Antigonish and 63 in Pictou according to map and census data 1600-1735.[60]

In the mid-seventeenth century, Nicholas Denys wrote that during the spring, families ascended the Pomquet River just to the east of Antigonish to trade their furs with fisherman. In 1716, the French missionary, Antoine Gaulin, established a mission at Antigonish which suggests that the area was the location of an important Mi'kmaq settlement. When English settlers occupied the region in 1784, a burial ground and chapel were discovered on an island in the harbour. On December 18, 1761, a French official traveling from Port Dauphin to Fort Lawrence located near Chignecto saw five Mi'kmaq wigwams at Antigonish. During the early nineteenth century, the Mi'kmaq were living at Pomquet, which lies to the east suggesting that this region had constituted part of their territory. After 1760, habitation of the area continued, as people were encountered along the coastline at Pictou during mid February and early May. In winter, some families migrated inland to hunt, as shown by a 1767 census which lists twenty-five individuals in the vicinity of Hopewell on the West River.[61]

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[58] Cameron, James M. **Pictou County's History,** p. 2.
[59] Cameron, James M. **Pictou County's History,** p. 3.
[60] Wicken, William C. **Encounters with tall sails and tall tales: Mi'kmaq Society, 1500-1632,** p. 96.

Their burial ground, when the English settled, was near the west end of Big Island on the south side, a short distance east of Savage Point. Here they buried up until the early part of the nineteenth century. The Mi'kmaq then buried on Indian Island. When the English arrived there was an Indian village at the mouth of the East River.[62]

Edward Mortimer recommended that part of the Philadelphia grant near Caribou Point be granted to the Indians in the county. He stated: "It would make a good reserve. There is plenty of grass, good soil, no roads, continuous hunting grounds, plenty of timber convenient for water carriage."[63] During the years 1819 – 1820 the government of the province finally divided the province into ten areas in which there was to be land set aside for the Indians. Unfortunately for the Indians in Pictou, they were not considered in the plan. In 1828, the Indians were prevented from planting crops and cutting firewood by a Mr. Mudie (to whom the land had been granted) even though the Indians lived on the spot for more than fifty years prior.[64]

In 1842 Robert McKay and some other people of Pictou petitioned the assembly for an allotment of land for the Indians in Pictou and again there was no action. On November 30, 1842 J. Dawson wrote to Joseph Howe asking if the Indians could reasonably expect anything in the shape of "Royal Bounty because the Indians never had more need of it." The Indians at the time were destitute and in need of clothing. On December 5 of that same year Howe replied by sending a few blankets and coats to be given to the aged and poor families only. In addition, Howe asked if there were crown lands available that would suit them for there would be no difficulty in getting a grant of 500 to 1000 acres Mr. Dawson wrote to the government in January of 1843 suggesting that Mr. McArthur at Boat Harbour would be willing to sell his land to the crown to be used by the Indians.

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[61] Wicken, William C. **Encounters with tall sails and tall tales: Mi'kmaq Society, 1500-1632,** p. 112.
[62] Francis, Barry. **Pictou Landing Reserve: A History,** p. 3.
[63] Francis, Barry. **Pictou Landing Reserve: A History,** p. 3.
[64] Francis, Barry. **Pictou Landing Reserve: A History,** p. 6.

The government did not adopt Mr. Dawson's recommendations, and it was some time before land was reserved for the Indians at Pictou.[65]

It wasn't until the eve of Confederation in 1867 that the Indians in Pictou were granted land. The amount of land purchased after more than eighty years was 50 acres. The land was not purchased by government funds, but funds collected from the sale of Indian land, which had been encroached upon in Cape Breton.[66] In 1874 another 89 acres were purchased from Wm. Ives for $1157 which became known as Fisher's Grant, 24 A. In 1876, 16 acres were cut off and exchanged for 11 acres of land, which became known as Fisher's Grant, 24 B. The Indians received less in the exchange but it gave the reservation access to both the Northumberland Gulf Shore and Boat Harbour. Additional parcels of land were acquired: In 1888, 30 acres known as 24 C, 35 acres in 1903 known as 24 D, 80 acres in 1907 known as 24 E, 120 acres in 1910 known as 24 F, and 128 acres in 1928 known as 24 G. All these parcels of land were acquired for firewood, which was much needed by the Indians.[67]

Indians from Indian Island moved to Pictou Landing to live where work was available close by. Now the island is uninhabited, but Indians all over the Maritimes visit each year in July to celebrate the "Feast of St. Anne's." Prior to 1838 the Indians used to have a similar celebration, usually in the month of September at Fraser's Point or Middle River Point. There would be about 100-150 canoes drawn up on shore while the two days would be spent in racing and other events.[68]

Archeological site BkCi-1 had three concentrations of flakes found along a 500m stretch of beach. The concentrations were found on the swampy lowland portion of the Troy Recreation Beach, Inverness County, Cape Breton. The entire lowland portion shows clear signs of periodic flooding which probably destroyed any sites situated on them.[69]

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[65] Francis, Barry. **Pictou Landing Reserve: A History,** p. 7.
[66] Francis, Barry. **Pictou Landing Reserve: A History,** p. 7.
[67] Francis, Barry. **Pictou Landing Reserve: A History,** p. 9.
[68] Francis, Barry. **Pictou Landing Reserve: A History,** p. 9.
[69] Davis, **Canso Survey, 1973**, Nova Scotia Museum Archeological Papers

5.2 Current Mi'kmaq Land and Resource Use

The study of current Mi'kmaq land and resource use is comprised of a study of current Mi'kmaq land and resource use sites, plants of significance to Mi'kmaq, and Mi'kmaw communities.

5.2.1 Current Mi'kmaq Land and Resource Use Sites

Current Mi'kmaq land and resource use activities are divided into five categories:

1) kill/hunting
2) burial/birth
3) ceremonial
4) gathering food/medicinal
5) occupation/habitation

Table 1 provides a description of activities undertaken at the sites.

Table 1: Description of Activities Undertaken in Current Mi'kmaq Land and Resource Use Sites

TYPE OF SITE	DESCRIPTION OF ACTIVITIES IN STUDY AREA
HUNTING/KILL	Fox, beaver, muskrat, coyote, otter, porcupine, duck, goose, rabbit, partridge, raccoon, deer, salmon, trout, eel, striped bass, gaspereau, crab, lobster, mussel, cod, smelt, mackerel, quahogs, clam, perch, traplines
BURIAL/BIRTH	Burial sites
CEREMONIAL	Ceremony site, sacred area
GATHERING	Specialty wood, food plants, logs, berries, feathers, stone, clay, wild fruit, medicinal plants, firewood, sweet grass, eggs
HABITATION	Group campsites, overnight sites, canoe routes

The sites occur in especially dense concentrations near Tracadie River, Paq'tnkek Reserve and Afton River, West Afton River, and Pomquet Harbour, Antigonish Harbour and South River and West River, Merigomish Harbour and Barneys River, and Pictou Harbour and the East

River of Pictou.

A 6.2 ha food and medicinal plant harvesting area is located on the north side of the existing highway along the western side of the Pomquet River (see Figure 4).

5.2.2 Plants of Significance to Mi'kmaq present in study areas

Plants of significance to Mi'kmaq in the study areas are divided into three categories:

1) Medicinal
2) Food/Beverage
3) Craft/Art

The following table describes the number of plants of significance present in the study areas.

Table 2: Number of Plants of Significance to Mi'kmaq Present in the New Glasgow to Sutherlands River Study Areas

TYPE OF USE	NUMBER OF SPECIES PRESENT
MEDICINAL	124
FOOD/BEVERAGE	20
CRAFT/ART	20

Table 3: Number of Plants of Significance to Mi'kmaq Present in the Addington Forks to Taylor Road Study Areas

TYPE OF USE	NUMBER OF SPECIES PRESENT
MEDICINAL	73
FOOD/BEVERAGE	19
CRAFT/ART	21

5.2.3 Mi'kmaw Communities

The Pictou Landing and Paq'tnkek First Nations control reserves within the study area. Pictou Landing controls a reserve in Merigomish Harbour consisting of two islands, Merigomish A, with an area of 15.9 ha, and Merigomish B, with an area of 6 ha. Paq'tnkek First Nation controls the Paq'tnkek reserve which consists of three lots, Lot A with an area of 79 ha Lot B with an area of 84 ha and Lot C with an area of 45 ha. The

Paq'tnkek First Nation also controls the Summerside reserve with an area of 43.94 ha. The existing highway intersects the southern portions of Lots A, B, and C of the Paq'tnkek reserve. The locations of the reserves are marked in Figure 2.

The Paq'tnkek First Nation submitted a specific land claim dealing with a breach of fiduciary trust responsibility for the Trans-Canada highway right of way in September 1968. The claim deals with a lack of provision of highway crossings in Lot A and B to permit access to lands on the south side of the highway. The claim has not yet been settled and will be resubmitted in the near future. There are also two specific land claims dating to 1932 and 1938 dealing with surrenders for highway road allowance that are currently on the Specific Claims Inventory List but have not yet begun the research stage.

There is a specific land claim for the loss of reserve land in Lot C of the Paq'tnkek Reserve near Heatherton. The reserve is plotted on older Canada Land Surveys Records as having an area of 120 acres (49 ha). The current Canada Land Surveys Record depicts a total area of only 105.5 acres (43 ha). The claim is currently in the research stage and has not yet been submitted.

6.0 POTENTIAL PROJECT IMPACTS ON MI'KMAQ LAND AND RESOURCE USE

The following table presents potential project impacts on historic and current Mi'kmaq land and resource use.

Table 3: Potential Project Impacts on Mi'kmaq Land and Resource Use

POTENTIAL IMPACTS ON MI'KMAQ LAND AND RESOURCE USE	
6.01	The historic review of Mi'kmaq use and occupation documents considerable historic Mi'kmaq use and occupation in the project area. A potential impact of the project is the disturbance of archaeological resources.
6.02	Numerous identified Mi'kmaw hunting/kill sites are located within the project construction corridor of the definitive route. A potential effect of the project is the temporary and/or permanent loss of access to these sites.
6.03	A 6.2 ha food and medicinal plant harvesting area is located on the north side of the existing highway along the western side of the Pomquet River. A potential effect of the Project, if the highway is twinned on the northern side of the existing highway across the Pomquet River, is the permanent loss of some of the harvesting area.
6.04	277 plant species of significance to Mi'kmaq have been identified in the study areas in the New Glasgow to Sutherlands River and the Antigonish sections of the twinning project (*i.e.*, sections with definitive alignments). Permanent loss of some specimens is an impact of the Project.
6.05	The existing highway intersects the southern portions of Lot A, B, and C, of the Paq'tnkek reserve. The project has the potential to effect land use, the local transportation network, the economy, human health and safety, the community lifestyle, green space, and specific land claims.

7.0 SIGNIFICANCE OF POTENTIAL PROJECT IMPACTS ON MI'KMAQ LAND AND RESOURCE USE

The concept of significance in the Mi'kmaw Knowledge Study is distinct from the concept of significance under the *Canadian Environmental Assessment Act* or the *Nova Scotia Environmental Assessment Regulations*. Significance to Mi'kmaq is evaluated only in accordance with the criteria listed below. The MKS evaluation of the significance of the potential project impacts on Mi'kmaq should be used by regulators to inform their determination of the significance of the environmental effects of the Project.

7.1 Significance Criteria

The following criteria are used to analyze the significance of the potential project impacts on Mi'kmaq use:

1) Uniqueness of land or resource
2) Culture or spiritual meaning of land or resource
3) Nature of Mi'kmaq use of land or resource
4) Mi'kmaq constitutionally protected rights in relation to land or resource

7.2 Evaluation of Significance

Table 4: Significance of Potential Project Impacts on Mi'kmaq Land and Resource Use

POTENTIAL IMPACT		EVALUATION OF SIGNIFICANCE	
6.01	The historic review of Mi'kmaq use and occupation documents considerable historic Mi'kmaq use and occupation in the project area. A potential impact of the project is the disturbance of archaeological resources.	7.2.01	Mi'kmaw archaeological resources are extremely important to Mi'kmaq as a method of determining Mi'kmaw use and occupation of Mi'kma'ki and as an enduring record of the Mi'kmaq nation and culture across the centuries. Archaeological resources are irreplaceable. Any disturbance of Mi'kmaw archaeological resources is significant.
6.02	Numerous identified Mi'kmaw hunting/kill sites are located within the project construction corridor of the definitive route. A potential effect of the project is the temporary and/or permanent loss of access to these sites.	7.2.02	Hunting/kill sites identified within the project construction corridor of the definitive route exist within the surrounding area. The temporary and/or permanent loss of access to these sites does not pose a threat to Mi'kmaw use within the surrounding area. The impact of the temporary and/or permanent loss of access to identified hunting/kill sites within the construction corridor of the definitive route is evaluated as not likely significant.
6.03	A 6.2 ha food and medicinal plant harvesting area is located on the	7.2.03	The gathering area is used by several members of the Paq'tnkek

POTENTIAL IMPACT		EVALUATION OF SIGNIFICANCE	
	north side of the existing highway along the western side of the Pomquet River. A potential effect of the Project, if the highway is twinned on the northern side of the existing highway across the Pomquet River, is the permanent loss of some of the harvesting area.		First Nation. The permanent loss of some of the harvesting area is potentially significant.
6.04	277 plant species of significance to Mi'kmaq have been identified in the study areas in the New Glasgow to Sutherlands River and the Antigonish sections of the twinning project (*i.e.*, sections with definitive alignments). Permanent loss of some species is an impact of the Project.	7.2.04	The plant species of significance to Mi'kmaq identified within the study areas exist within the surrounding area. The destruction of some specimens within the study areas does not pose a threat to Mi'kmaq use of the species. The impact of the permanent loss of some specimens of plant species of significance to Mi'kmaq is evaluated as not likely significant.
6.05	The existing highway intersects the southern portions of Lot A, B, and C, of the Paq'tnkek reserve. The project has the potential to effect land use, the local transportation network, the economy, human health and safety, the community lifestyle, green space, and specific land claims.	7.2.05	The potential impacts of the project may be positive and negative and have the potential to be significant to the Paq'tnkek First Nation.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The following chart outlines Mi'kmaq Environmental Services' recommendations to the Project proponent.

Table 5: Recommendations

RECOMMENDATIONS	
8.01	The results of the Mi'kmaw Knowledge Study should be used during the Archaeological Impact Assessments for the Highway 104 twinning and improvement projects from Sutherlands River to Addington Forks and Taylors Road to Aulds Cove to aid in the identification of sites of high potential for Mi'kmaw archaeological resources and sites of particular sensitivity.
8.02	In the event that Mi'kmaw archaeological deposits are encountered during construction of the Project, all work should be halted and immediate contact should be made with David Christianson at the Nova Scotia Museum and Don Julien at The Confederacy of Mainland Mi'kmaq.
8.03	Nova Scotia Transportation and Public Works should communicate with The Confederacy of Mainland Mi'kmaq during route selection from Sutherlands River to Addington Forks and Taylor Rd. to Aulds Cove. CMM will reevaluate hunting/kill site data collected during the MKS in the context of the potential route selections at that time.
8.04	The location of the gathering area should be taken into account during route selection for the Taylor Rd. to Aulds Cove section.
8.05	A study of plants of significance to Mi'kmaq will be required once the definitive alignments from Sutherlands River to Addington Forks and Taylor Rd. to Aulds Cove are known.
8.06	The proponent should open discussions with the Paq'tnkek First Nation as soon as possible to discuss the potential effects of the project on the Paq'tnkek First Nation.

9.0 SUMMARY OF POTENTIAL IMPACTS, EVALUATION OF SIGNIFICANCE, AND RECOMMENDATIONS

Table 6: Summary of Potential Impacts, Evaluation of Significance, and Recommendations

POTENTIAL IMPACT	EVALUATION OF SIGNIFICANCE	RECOMMENDATION
6.01 The historic review of Mi'kmaq use and occupation documents considerable historic Mi'kmaq use and occupation in the project area. A potential impact of the project is the disturbance of archaeological resources.	7.2.01 Mi'kmaw archaeological resources are extremely important to Mi'kmaq as a method of determining Mi'kmaw use and occupation of Mi'kma'ki and as an enduring record of the Mi'kmaq nation and culture across the centuries. Archaeological resources are irreplaceable. Any disturbance of Mi'kmaw archaeological resources is significant.	8.01 The results of the Mi'kmaw Knowledge Study should be used during the Archaeological Impact Assessments for the Highway 104 twinning and improvement projects from Sutherlands River to Addington Forks and Taylors Road to Aulds Cove to aid in the identification of sites of high potential for Mi'kmaw archaeological resources and sites of particular sensitivity. 8.02 In the event that Mi'kmaw archaeological deposits are encountered during construction of the Project, all work should be halted and immediate contact should be made with David Christianson at the Nova Scotia Museum and Don Julien at the Confederacy of Mainland Mi'kmaq.
6.02 Numerous identified Mi'kmaw hunting/kill sites are located within the project construction	7.2.02 Hunting/kill sites identified within the project construction corridor of the definitive route	8.03 Nova Scotia Transportation and Public Works should communicate with the Confederacy of Mainland

POTENTIAL IMPACT	EVALUATION OF SIGNIFICANCE	RECOMMENDATION
corridor of the definitive route. A potential effect of the project is the temporary and/or permanent loss of access to these sites.	exist within the surrounding area. The temporary and/or permanent loss of access to these sites does not pose a threat to Mi'kmaw use within the surrounding area. The impact of the temporary and/or permanent loss of access to identified hunting/kill sites is evaluated as not likely significant.	Mi'kmaq during route selection from Sutherlands River to Addington Forks and Taylor Rd. to Aulds Cove. CMM will reevaluate hunting/kill site data collected during the MKS in the context of the potential route selections at that time.
6.03 A 6.2 ha food and medicinal plant harvesting area is located on the north side of the existing highway along the western side of the Pomquet River. A potential effect of the Project, if the highway is twinned on the northern side of the existing highway across the Pomquet River, is the permanent loss of some of the harvesting area.	7.2.03 The gathering area is used by several members of the Paq'tnkek First Nation. The permanent loss of some of the harvesting area is potentially significant.	8.04 The location of the gathering area should be taken into account during route selection for the Taylor Rd. to Aulds Cove section.
6.04 277 plant species of significance to Mi'kmaq have been identified in the study areas in the New Glasgow to Sutherlands River and the Antigonish sections of the	7.2.04 The plant species of significance to Mi'kmaq identified within the study areas exist within the surrounding area. The destruction of some specimens within the	8.05 A study of plants of significance to Mi'kmaq will be required once the definitive alignments from Sutherlands River to Addington Forks and Taylor Rd. to Aulds Cove are

POTENTIAL IMPACT	EVALUATION OF SIGNIFICANCE	RECOMMENDATION
twinning project (*i.e.*, sections with definitive alignments). Permanent loss of some species is an impact of the Project.	study areas does not pose a threat to Mi'kmaq use of the species. The impact of the permanent loss of some specimens of plant species of significance to Mi'kmaq is evaluated as not likely significant.	known.
6.05 The existing highway intersects the southern portions of Lot A, B, and C, of the Paq'tnkek reserve. The project has the potential to effect land use, the local transportation network, the economy, human health and safety, the community lifestyle, green space, and specific land claims.	7.2.05 The potential impacts of the project may be positive and negative and have the potential to be significant to the Paq'tnkek First Nation.	8.06 The proponent should open discussions with the Paq'tnkek First Nation as soon as possible to discuss the potential effects of the project on the Paq'tnkek First Nation.

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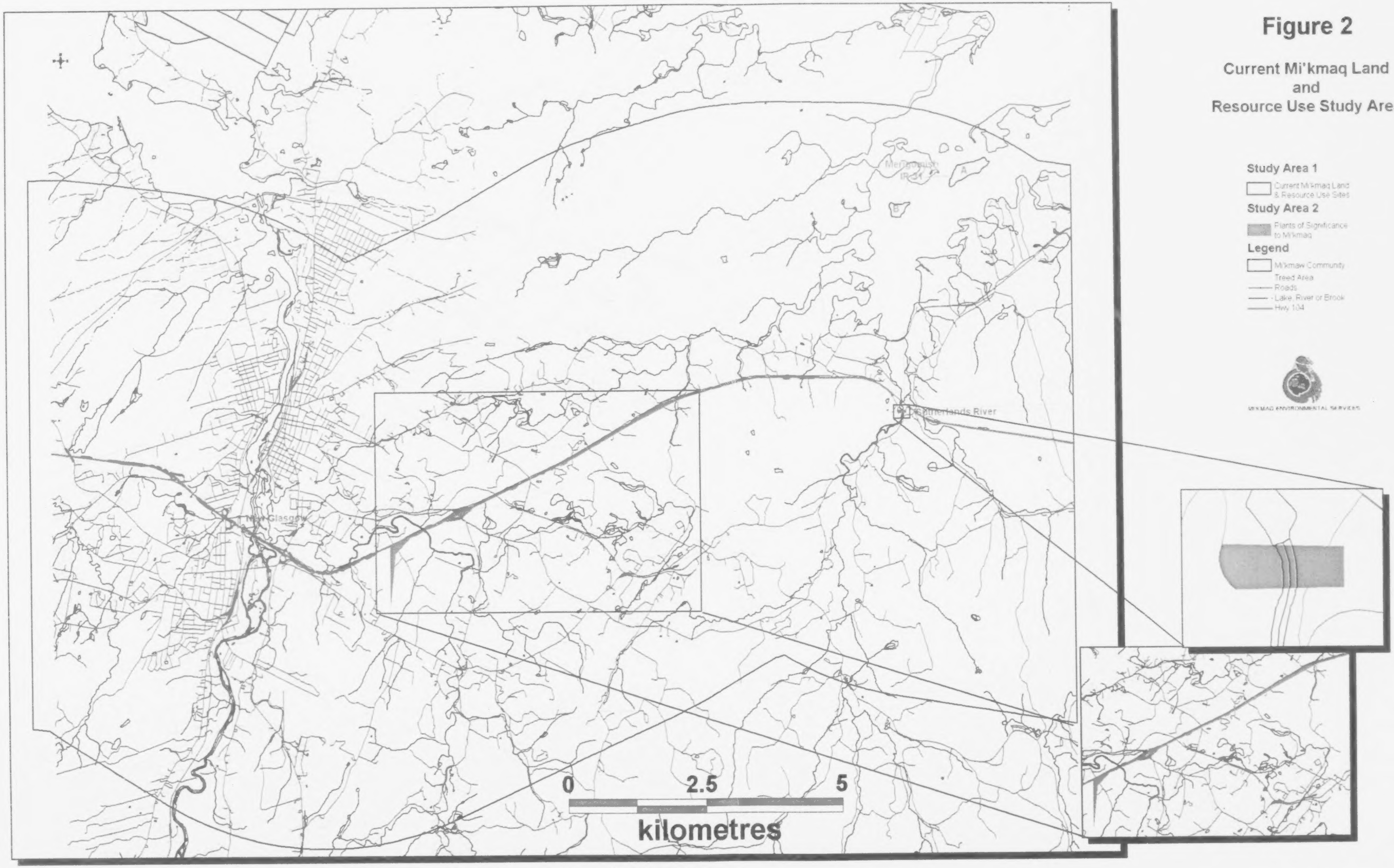


Figure 2

Current Mi'kmaq Land
and
Resource Use Study Area

Figure 3

Current Mi'kmaq Land and Resource Use Study Areas

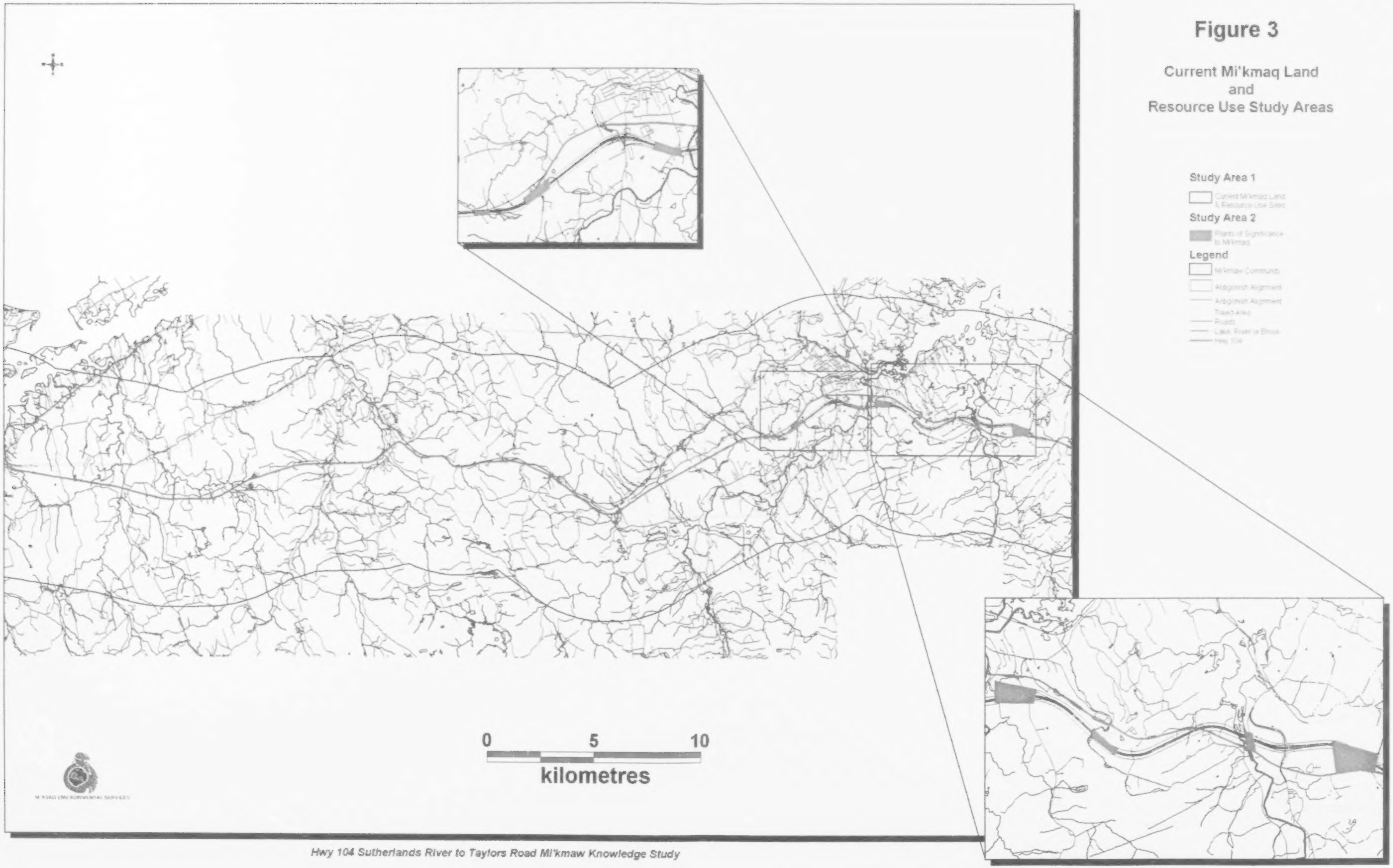
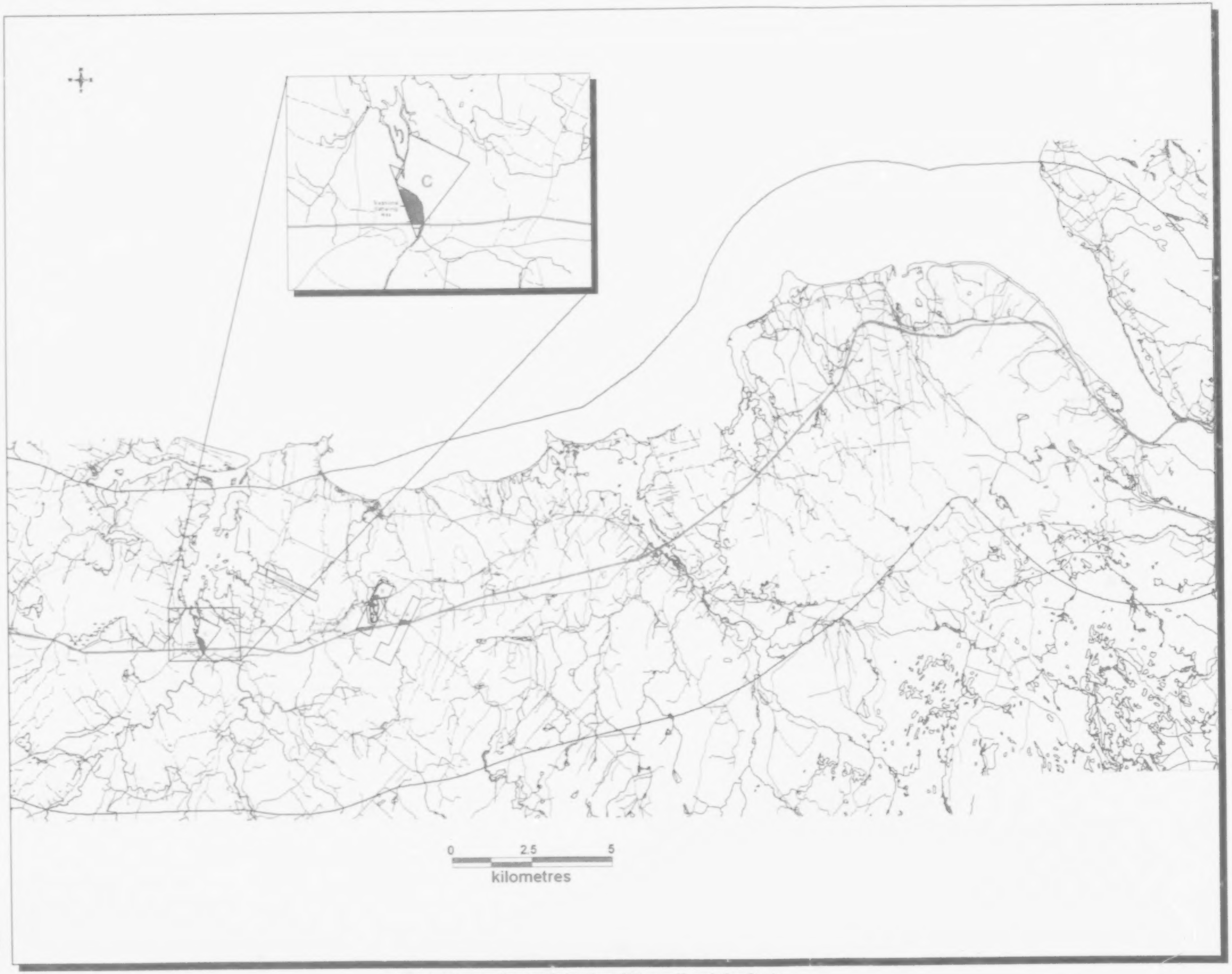


Figure 4

Current Mi'kmaq Land and Resource Use Study Areas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Study Area 1
Current Mi'kmaq Land & Resource Use Sites
Traditional Gathering Area
Legend
Mi'kmaw Community
Treed Area
Roads
Lake, River or Brook
Hwy 104

MI'KMAQ ENVIRONMENTAL SERVICES

APPENDIX L

SALT MANAGEMENT STRATEGY

Highway 104 at Antigonish
Salt Management Strategy

1.0 Background

Numerous studies have confirmed that elevated chloride levels in surface waters are linked to winter maintenance activities (*i.e.* salt storage and application of road salt as a deicing agent). Significant salt releases into aquatic areas of small drainage size put these areas at high risk. Surges of high chloride concentration from road salt typically occur during the winter and thaw months. Small streams, ponds, and wetlands close to the salted highway are susceptible to high salt loading, and combined with soil erosion due to salt-damaged vegetation, can exert stress on the aquatic ecology. Rapid changes in stream chloride levels during and following the winter salting period, rather than the high absolute values of chloride, may also stress fish and other aquatic life.

Salt stored in the groundwater and soils may also be released to streams over a several month period. Salt released during low flow summer months may be more concentrated when biotic activity is the highest. It is estimated that between 10% and 50% of salt applied to roads enters into the groundwater system and between 20% and 45% of chlorides applied to roads travels through the groundwater system and re-enters surface waters. In the rural area along the proposed alignment, much of the road salt may enter the subsurface along the highway where no surface drainage exists.

Overall, harmful effects on aquatic life from salt pollution depends on oxygen supply in the water, water circulation, size of waterbody and drainage basin, temperature, length of exposure to salt, salting intensity, precipitation, topography, and type of highway drainage system.

Elevated levels of sodium chloride in soils may affect soil structure, soil pH, soil fertility, and the mobilization of trace metals. Extensive salt infiltration into soils can decrease the fertility of soils and subsequently be detrimental to plant growth.

2.0 Notification of Intent to Prepare a Salt Management Plan

As per Section 15(a) of the "Code of Practice for the Environmental Management Of Road Salts", published April 3, 2004, the Nova Scotia Department of Transportation and Public Works (NSTPW) notified Environment Canada on June 23, 2004, that they moved forward with the development of a Salt Management Plan (SMP). The SMP was developed to comply with the requirements of the aforementioned Code of Practice. In addition, NSTPW will report information annually to Environment Canada on their performance with respect to the SMP, as it is implemented and updated.

The SMP provides a mechanism through which NSTPW can commit to implementing salt best management practices while fulfilling its obligation to providing safe, efficient, and cost effective roadway systems. The SMP identifies four specific winter maintenance programs in compliance with the concerns expressed by Environment Canada. These concerns include:

(1) Storage and handling;
(2) Salt application;
(3) Salt vulnerable areas; and
(4) Training.

As part of the SMP, a preliminary Salt Vulnerability Map was developed. The purpose of this mapping and rating matrix is to assist in determining the order winter maintenance facilities receive new storage facilities and to determine sites where groundwater chloride levels should be monitored. Using several physical and land use factors relevant to salt mobility and impact, a preliminary map of salt impact vulnerability was generated using a GIS mapping approach. The zones of highest risk are based on hydrogeological and hydrologic constraints. The 53 NSTPW winter maintenance facilities are rated for further scrutiny based on the volumes of salt and sand stored, their mode of operation, and their location within the established provincial salt vulnerability zones. Finally, the major highways (100 Series and Trunks) and 200 and 300 Series roads are superimposed on the risk map to show areas of potential concern for future monitoring or mitigation.

This is a preliminary assessment that uses mapping that is based on readily available electronic mapping and databases. No fieldwork was done in conjunction with this mapping, and the results should be considered on a regional scale only. NSTPW plans to carry out the monitoring of chloride levels at a number of their winter maintenance facilities around the Province this in 2004/05. This will benchmark current concentrations against which future levels can be compared. Levels will be tracked to show progress (hopefully lower chloride levels) after best management practices have been implemented at these winter maintenance facilities.

A training module will be prepared for NSTPW's highway designers and planners as part of the Department's commitment to a Salt Management Plan. This training will provide them with the awareness and tools required to address salt best management practices in the planning and design stage to reduce the amount of road de-icing salt necessary to achieve NSTPW's winter maintenance standards.

3.0 Approach to the Salt Management Strategy

The following general activities will form the basis for development of an SMP for Highway 104.

- Identify salt vulnerable areas specific to the proposed alignment, using Annex "B" in the Code of Practice as a guide.
- Determine the exposure levels for negative impacts to aquatic and groundwater biota and soil (vegetation).
- Determine site specific vulnerable areas to be monitored along the proposed alignment.
- Identify applicable management strategies that can be incorporated in the design, construction, operation and maintenance of the proposed highway.
- Implement a monitoring program during winter, thaw and summer months (*i.e.* 3 events).
- Compare results to baseline samples to evaluate effectiveness of the strategy.

4.0 Salt Vulnerable Areas

Annex "B" of the Code of Practice lists a number of considerations that agencies should look for when identifying salt vulnerable areas.

Salt vulnerable areas along this specific alignment that should be considered in the management strategy include:

- Wetlands adjacent to the highway with low-dilution and long residence times;
- Areas where the addition of road salts has the potential to raise the chloride concentration, after mixing, to levels that could harm local fish or fish habitat; and
- Areas where the addition of road salts has the potential to harm the integrity of a life cycle, (*i.e.*, spawning grounds, rearing, food supply, and migration areas for birds).

5.0 Salt Vulnerable Areas Along Row Identified for Monitoring

An analysis of Salt Vulnerable Areas (Section 4) along the proposed Highway 104 at Antigonish has yielded a number of locations for monitoring (Table 1).

Table 1 Salt Vulnerable Areas for Monitoring

Area	Feature, Station Location	Importance
1	Wetland 6, Sta. 4+150	Overwintering fish habitat
2	West River, Sta. 5+700	Type 1 salmonid habitat
3	Stream Crossing No. 11, Sta. 8+150	Type 2 salmonid habitat
4	Wetland 12, Sta. 9+000	Fish eating birds and amphibian breeding habitat, wetland plant species
5	Wetland 15	Amphibian breeding habitat, wetland plant species

6.0 Table for Evaluating Negative Impacts

The following table (Table 2) will provide guidance during the operation and maintenance of the highway by identifying concentrations of chloride in the environment at which certain negative environmental impacts are likely to occur. The three areas of concern include surface water, groundwater, and soil (vegetation). Concentrations above these levels have the potential to result in negative impacts.

Table 2 Table for Evaluating Negative Impacts

Exposure	Surface Water – Aquatic Biota	Groundwater – Groundwater Biota	Soil – Soil Integrity, Soil Organisms, and Vegetation
Protective of Organisms for Short-Term Exposure	< 140 mg/L of chloride	< 140 mg/L of chloride	-
Protective of Organisms for Long-Term Exposure	< 35 mg/L of chloride	< 35 mg/L of chloride	< 60 mg Na/L and < 90 mg Cl/L
5 % of Species Experience Effects from Chronic Exposure	About 210 mg/L	About 210 mg/L	-
10 % of Species Experience Effects from Chronic Exposure	About 240 mg/L	About 240 mg/L	-
Protect Life From Acute and Lethal Effects	< 150 mg/L	< 150 mg/L	-
Damage to Plants	-	-	Concentrations of 16 mg Na/kg and 30 Cl/kg

Source: Environment Canada. 2004. Code of Practice for the Environmental Management of Road Salts. Annex A: Environmental Impact Indicators for Road Salts.

Surface water samples taken in July 2002, November 2002, and February 2003 at 15 stream crossings along the existing alignment of Highway 104 at Antigonish to indicate elevated chloride and sodium levels, particularly in the smaller watercourses and associated wetlands. Concentrations of chloride between 200 and 300 mg/L were observed in some of the smaller wetlands and up to 100 mg/L in some of the stream crossings.

7.0 Management Strategies

The following is a list of management strategies that may be considered in the design, construction, operation and maintenance of the proposed section of Highway 104, based on the salt vulnerable areas identified on this section of highway.

- Apply de-icing chemical using pre-wetting or direct liquid application and implement anti-icing principles to minimize salt application rates.
- TPW's current standard cross-section for 100 series highways has up to 6:1 side slopes and 4:1 back slopes, which reduces the potential for drifting snow.
- Berms or fences could be placed upwind of the roadway to reduce potential for drifting snow.
- Do not cut grass within the RoW (except directly adjacent to the highway) to encourage drifting immediately downwind of the berm or fence.
- Use clay or geosynthetic liners in conveyance ditches and berms to transport surface runoff past vulnerable areas where possible.
- Ensure runoff collected in median catch basins is not directed into salt vulnerable areas.

8.0 Monitoring Program

Monitoring should be carried out during winter, thaw and summer months (three events) to evaluate the effectiveness of the salt management strategy.

Test results should be compared to baseline concentrations of chloride and also to the exposure concentrations to determine if there are potential negative effects to aquatic and groundwater biota and vegetation.

Note: Halophytes are plants that are morphologically and/or physiologically adapted to grow in soils and air with relatively high levels of sodium chloride. Some of these halophyte species are well suited for use in roadside seed mixes and are better suited than conventional mixes. Such seed mixes should be investigated further as they tend to be hardier and require less maintenance.

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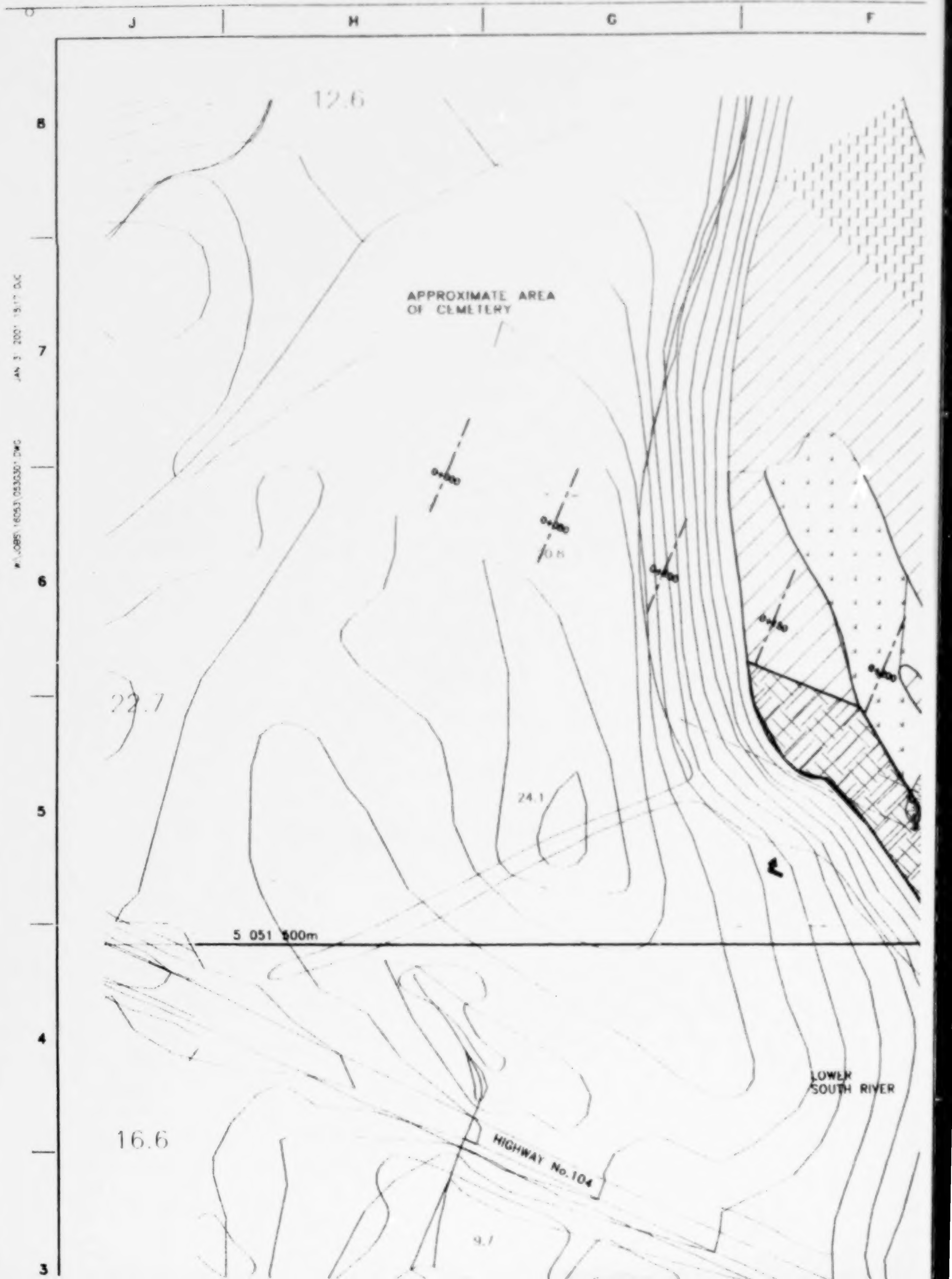
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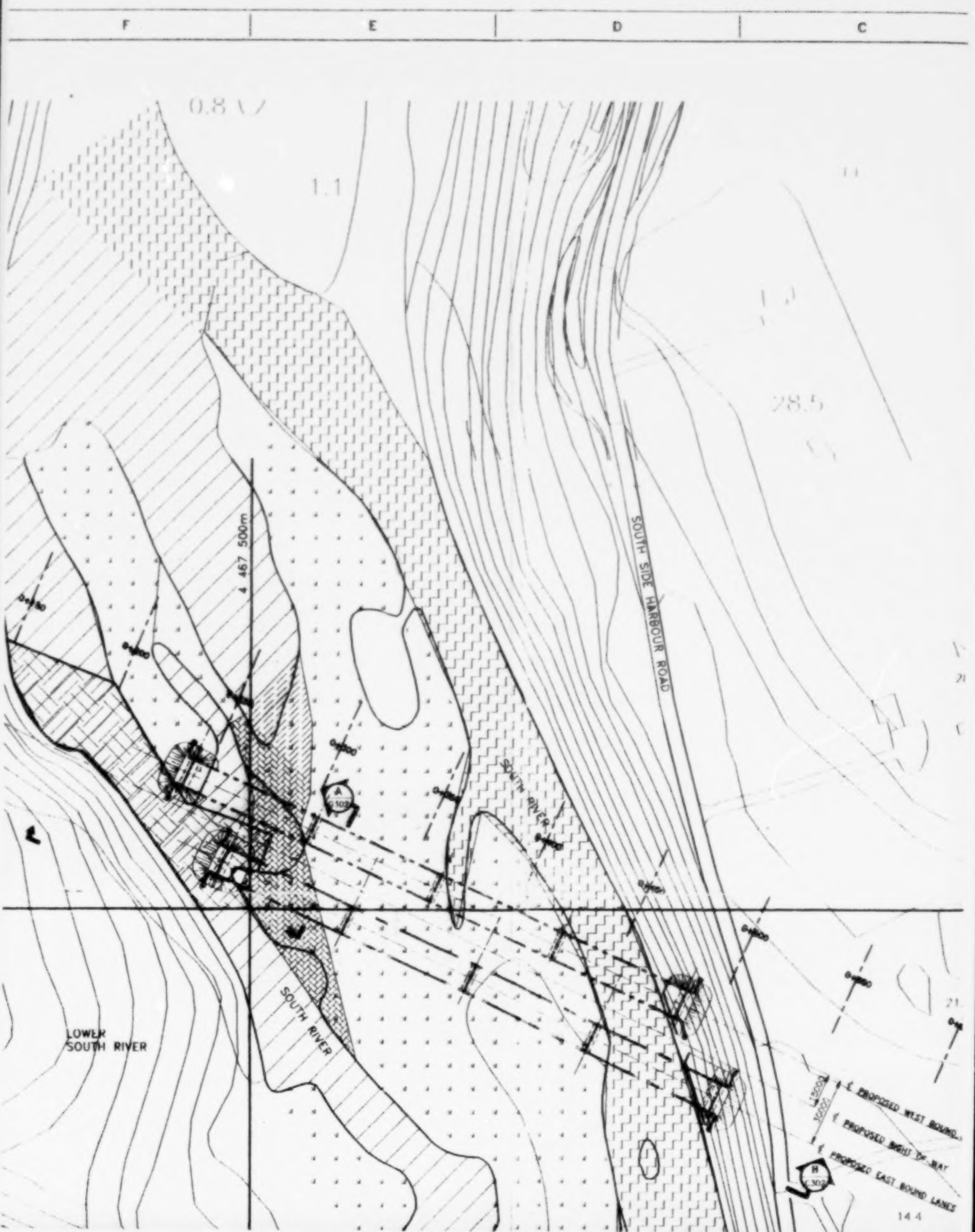F
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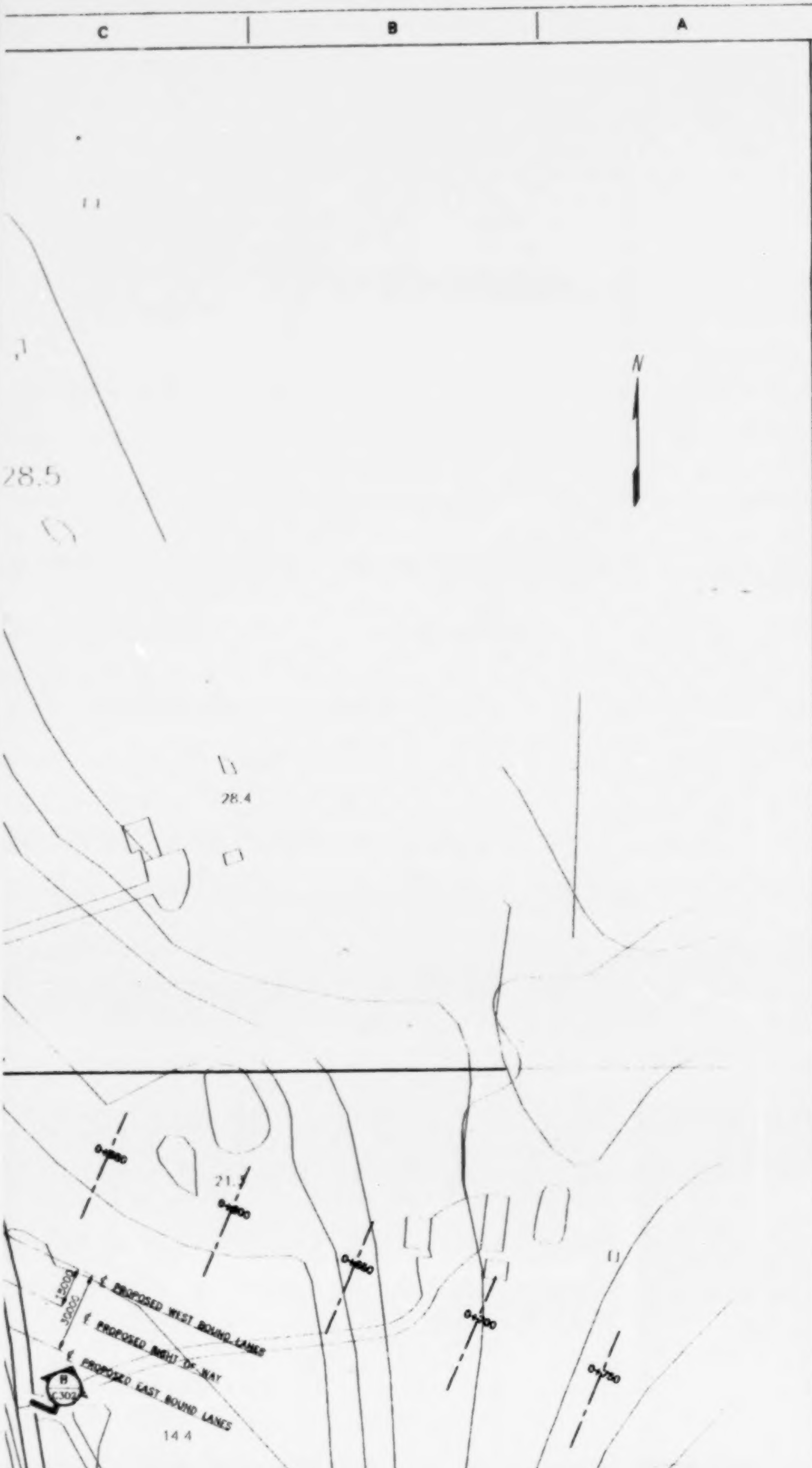

REFERENCE DRAWINGS

DWG.NO.	TITLE	BY
2 OF 2	CONCEPTUAL DESIGN PROFILES, SECTIONS AND DETAILS	[illegible]

NOTES:

1. DISTURBANCE TO SALT WATER MARSH TO BE MINIMIZED.
2. INSTALL SEDIMENT TRAPS AT DOWNSTREAM END OF ALL CONSTRUCTION SLOPES.
3. INSTALL SILT FENCING AROUND ALL MAJOR STRUCTURES. REMOVE ALL EXCAVATED MARSH MATERIAL FROM SITE.
4. PROTECT SALT WATER MARSH BY INSTALLING TEMPORARY ROADS ON 60MIL HDPE OR COURDROY ROADS.
5. USE TREMIE CONCRETE METHODS FOR PIER FOUNDATIONS BELOW WATER TABLE.
6. FOR BIOLOGICAL SAMPLING AND HABITAT SITES, SEE MAP 1.
7. ALL LOCATIONS ARE APPROXIMATE ONLY.

LEGEND:

▨	PROPOSED AREA TO BE BACKFILLED
▦	PROPOSED AREA TO TURN INTO BACK CHANNEL
▨	SOUTH RIVER BACK CHANNEL
▤	SOUTH RIVER

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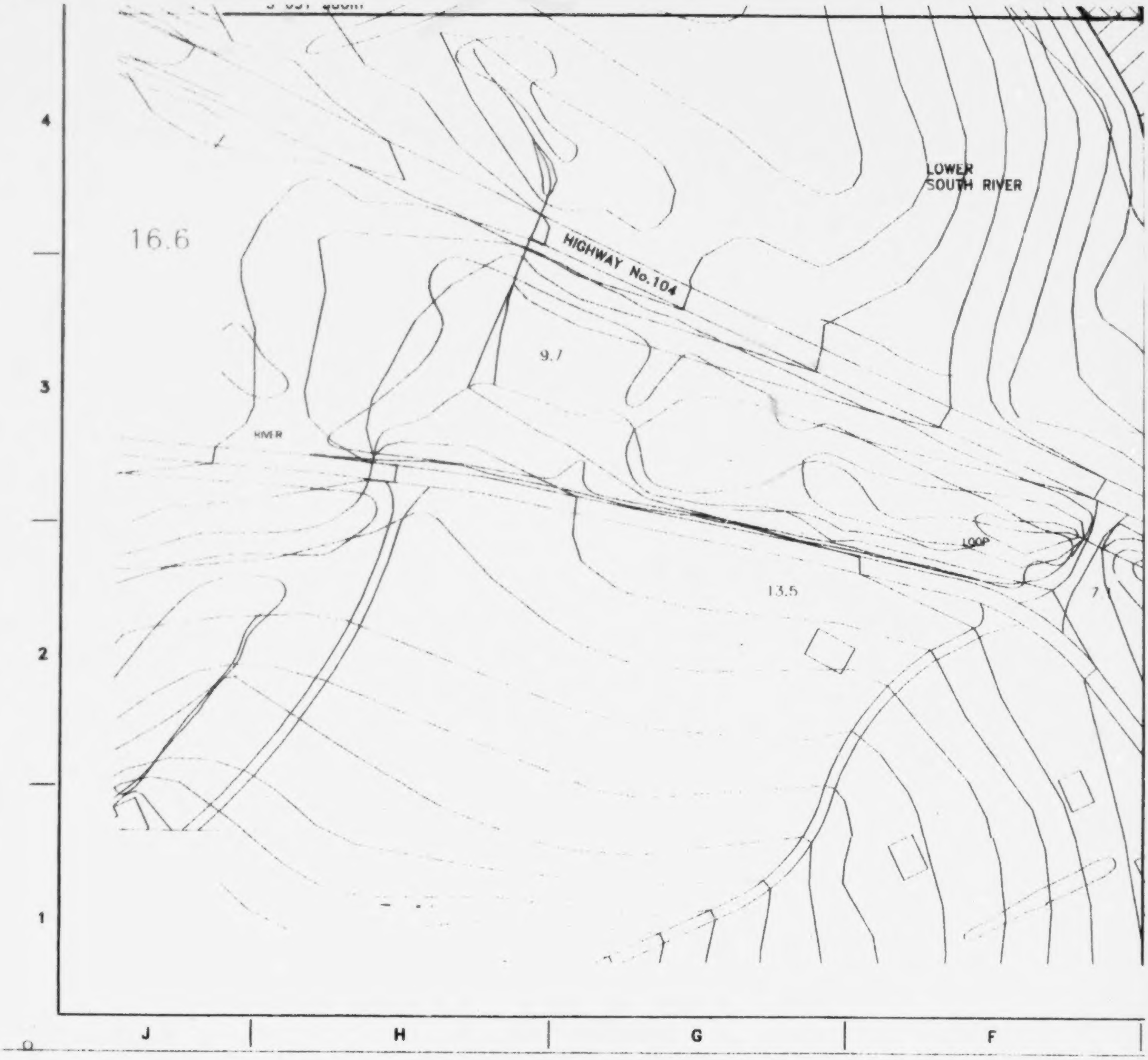
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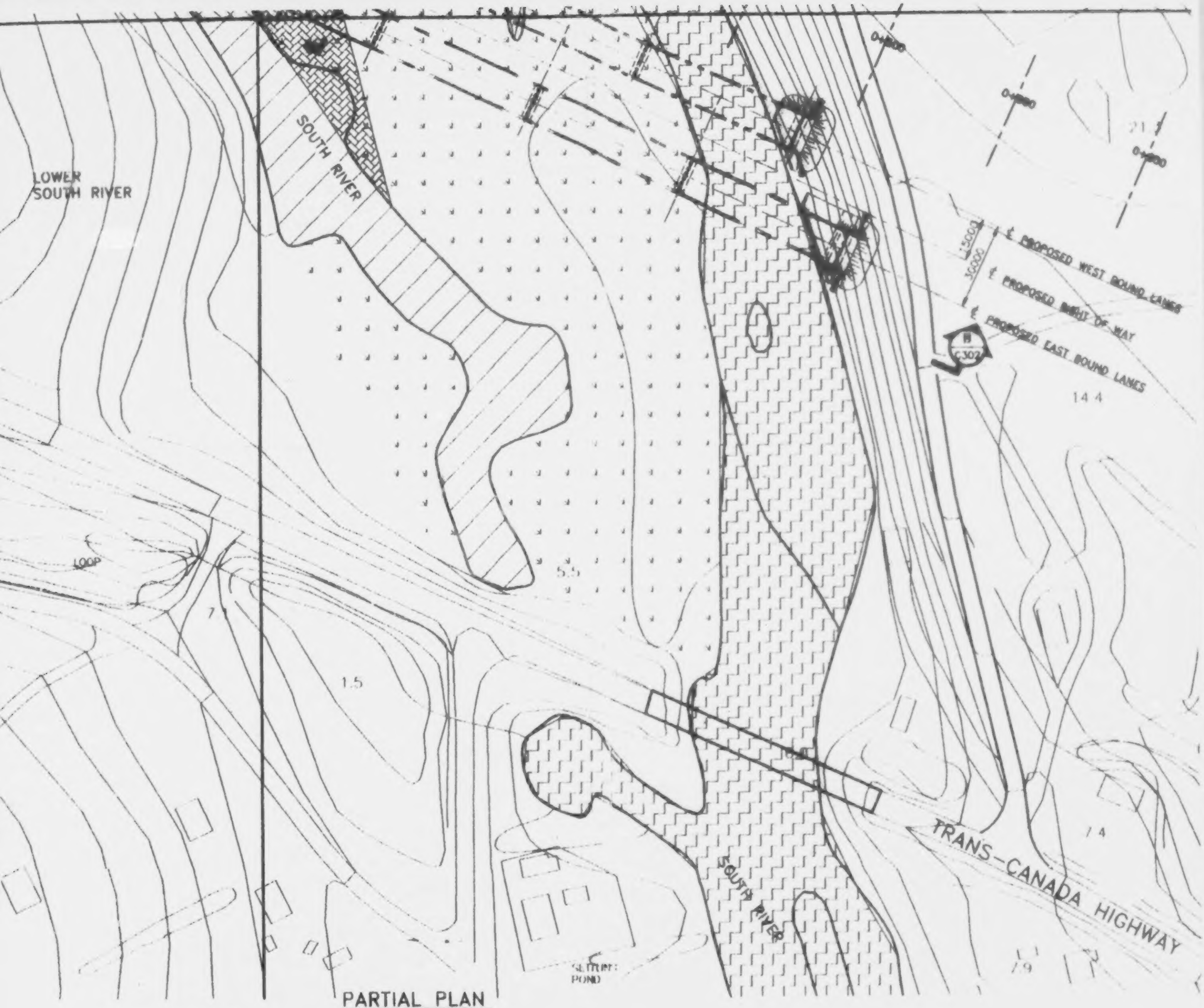

PARTIAL PLAN

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DARTMOUTH, N.S., CANADA

NOVA SCOTIA
Transportation and Public Works

Infrastructure
Management
Section

HIGHWAY 104 ANTIGONISH SOUTH RIVER IMPACT STUDY

HIGHWAY 104 ANTIGONISH
SOUTH RIVER IMPACT STUDY
PARTIAL PLAN & STUDY AREA

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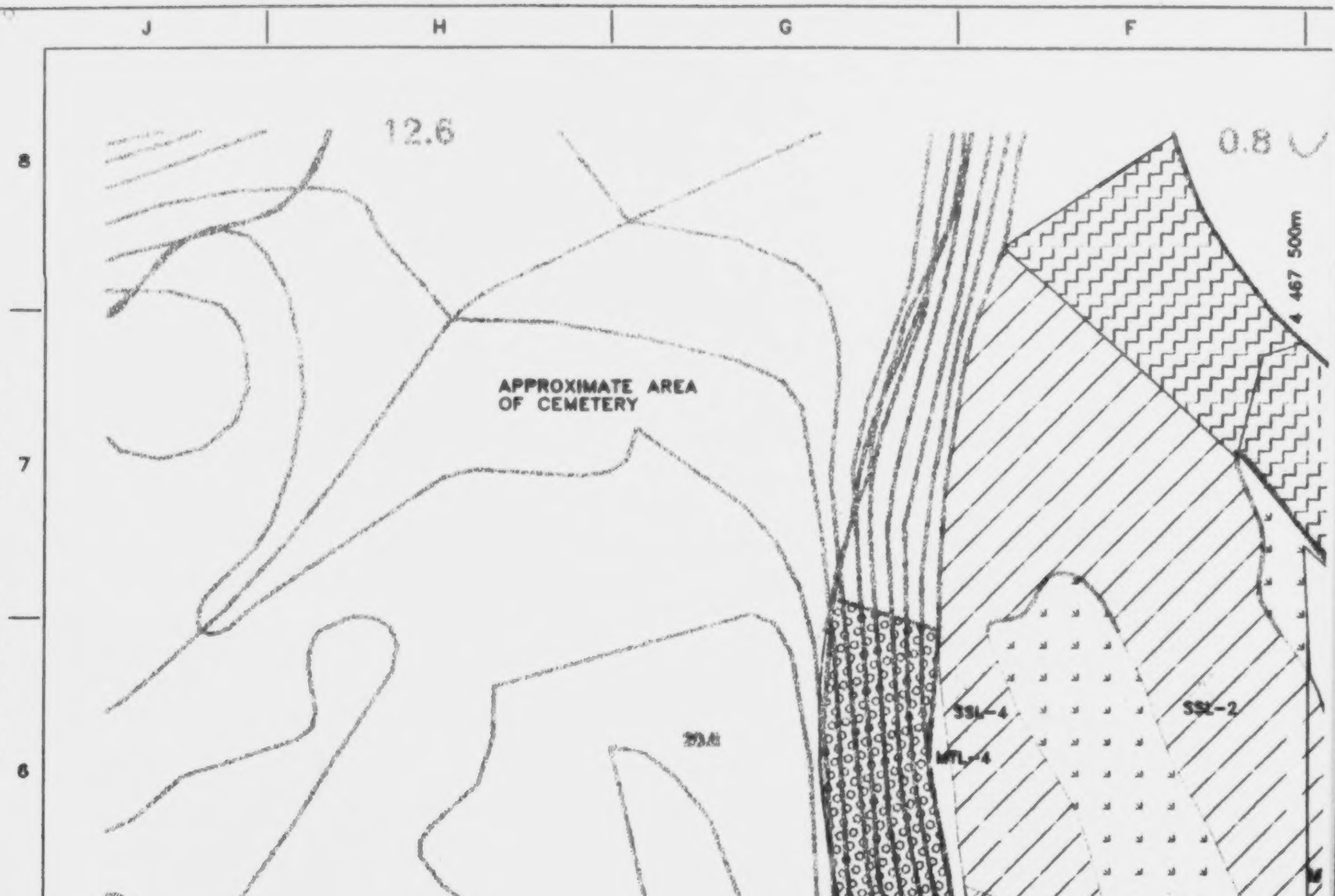
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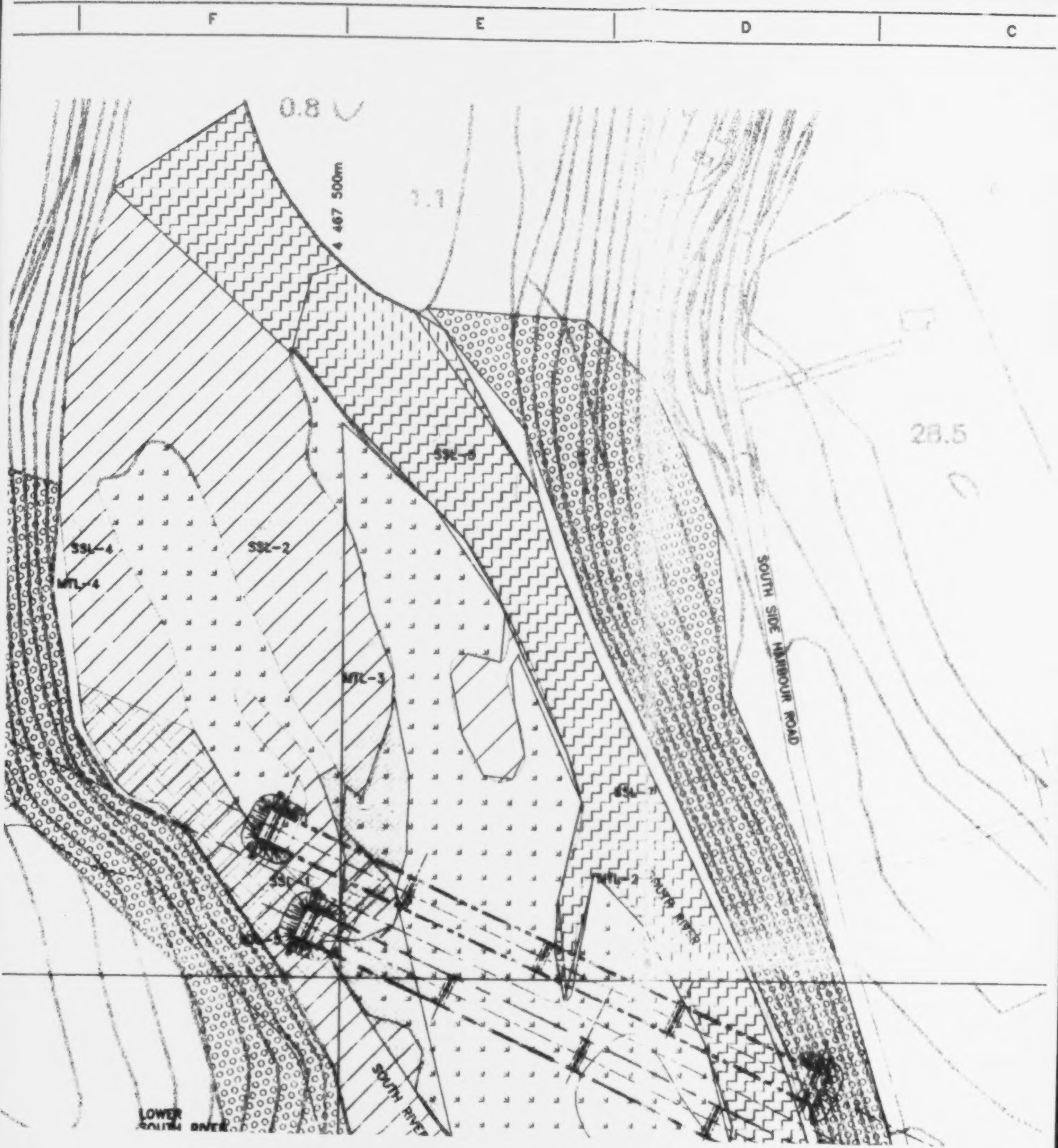
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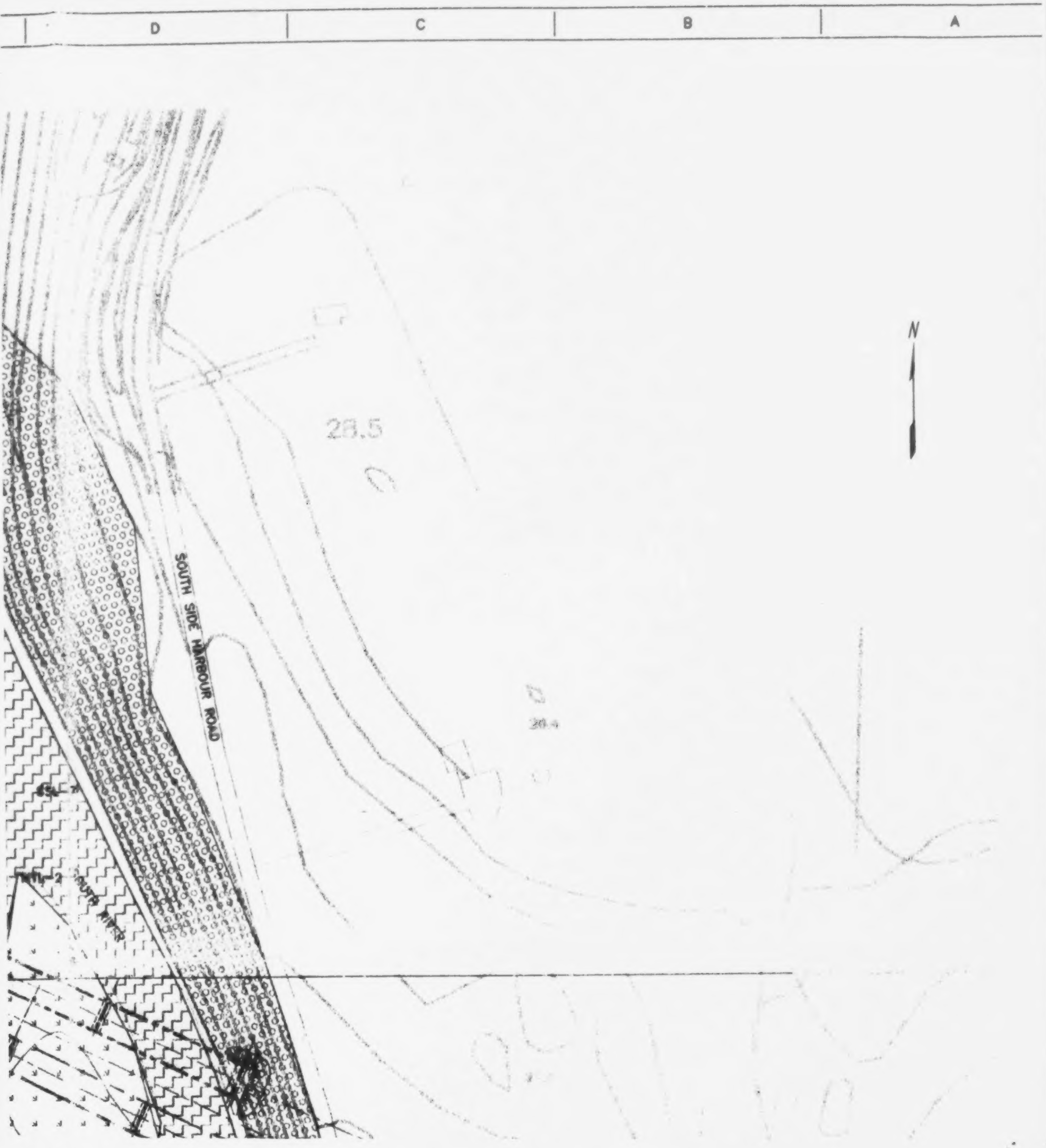
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NOTES:

1. FOR GENERAL NOTES SEE DWG. 1 OF 2.
2. FOR SECTION B-B, SEE SUBSURFACE PROFILE DWG. No. MAP-2.

LEGEND:

MTL-2 - MINNOW TRAP LOCATION

SSL-2 - SEDIMENT SAMPLE LOCATION

◆ BH-2 - BOREHOLE LOCATION

▭ MARSH VEGETATION

▨ BACKWATER CHANNEL

▦ MAIN RIVER CHANNEL

▩ MIXED WOODS

▨ PROPOSED AREA TO BE BACKFILLED.

▭ PROPOSED AREA TO TURN INTO BACK CHANNEL

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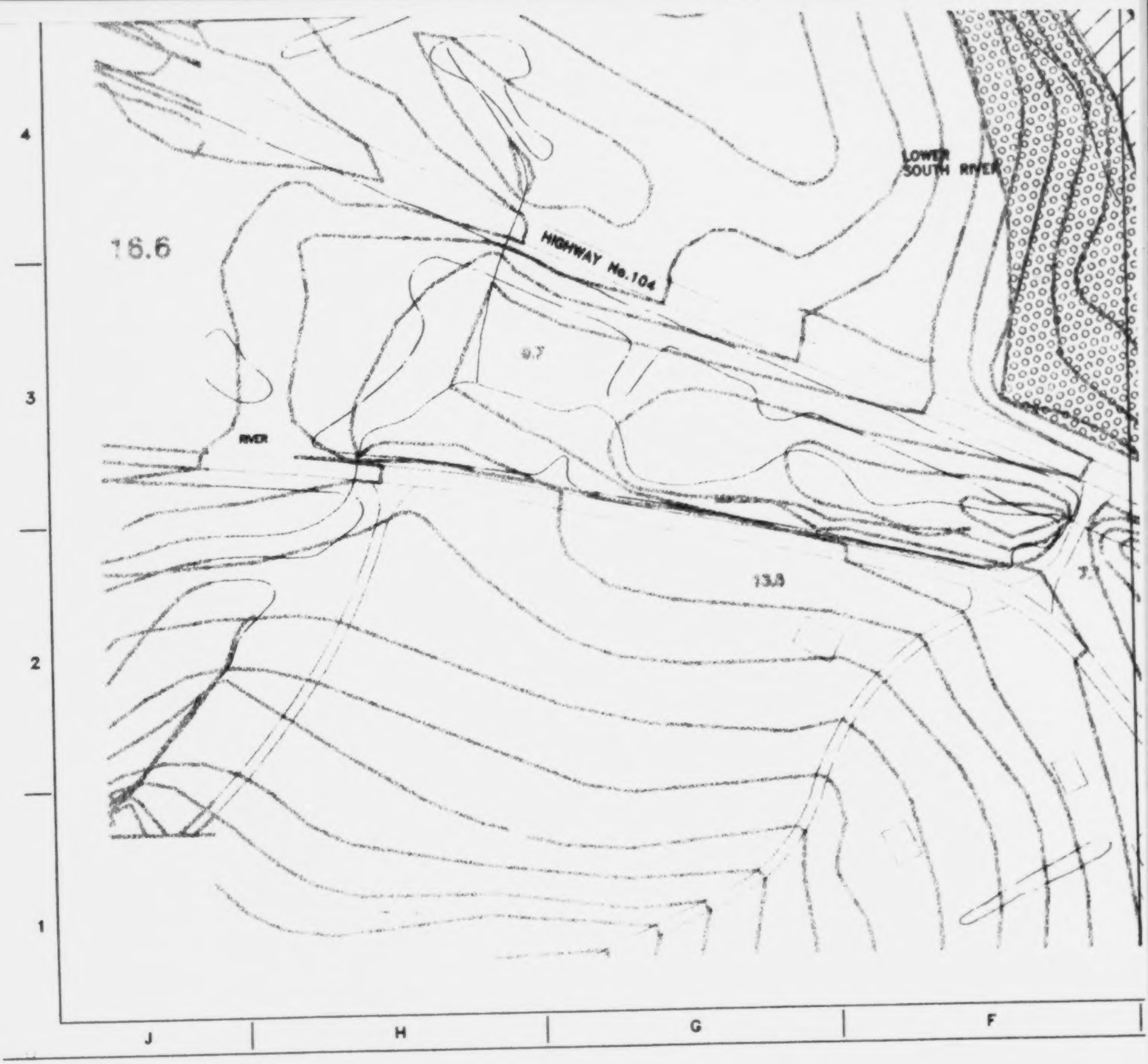
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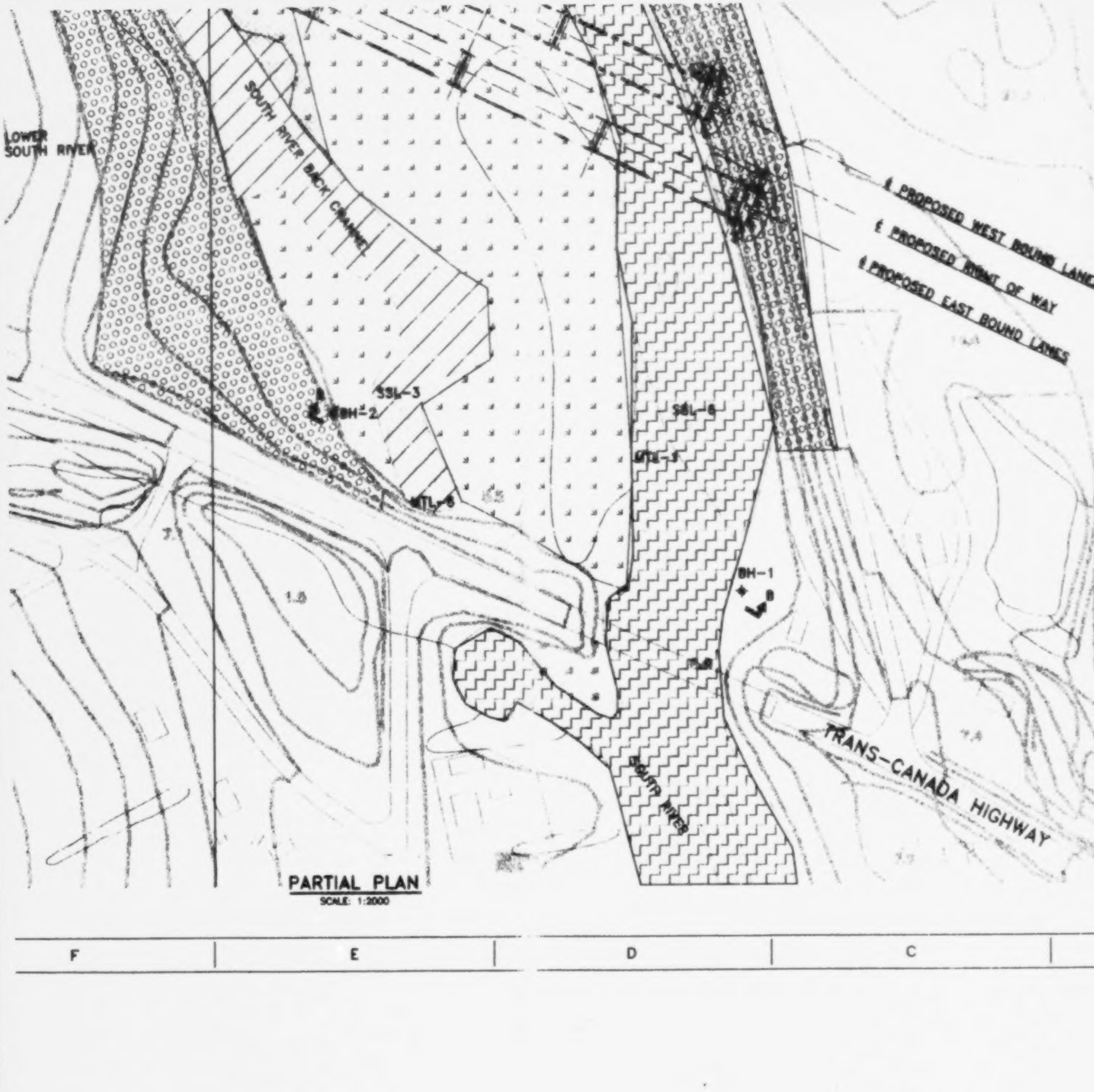

PARTIAL PLAN

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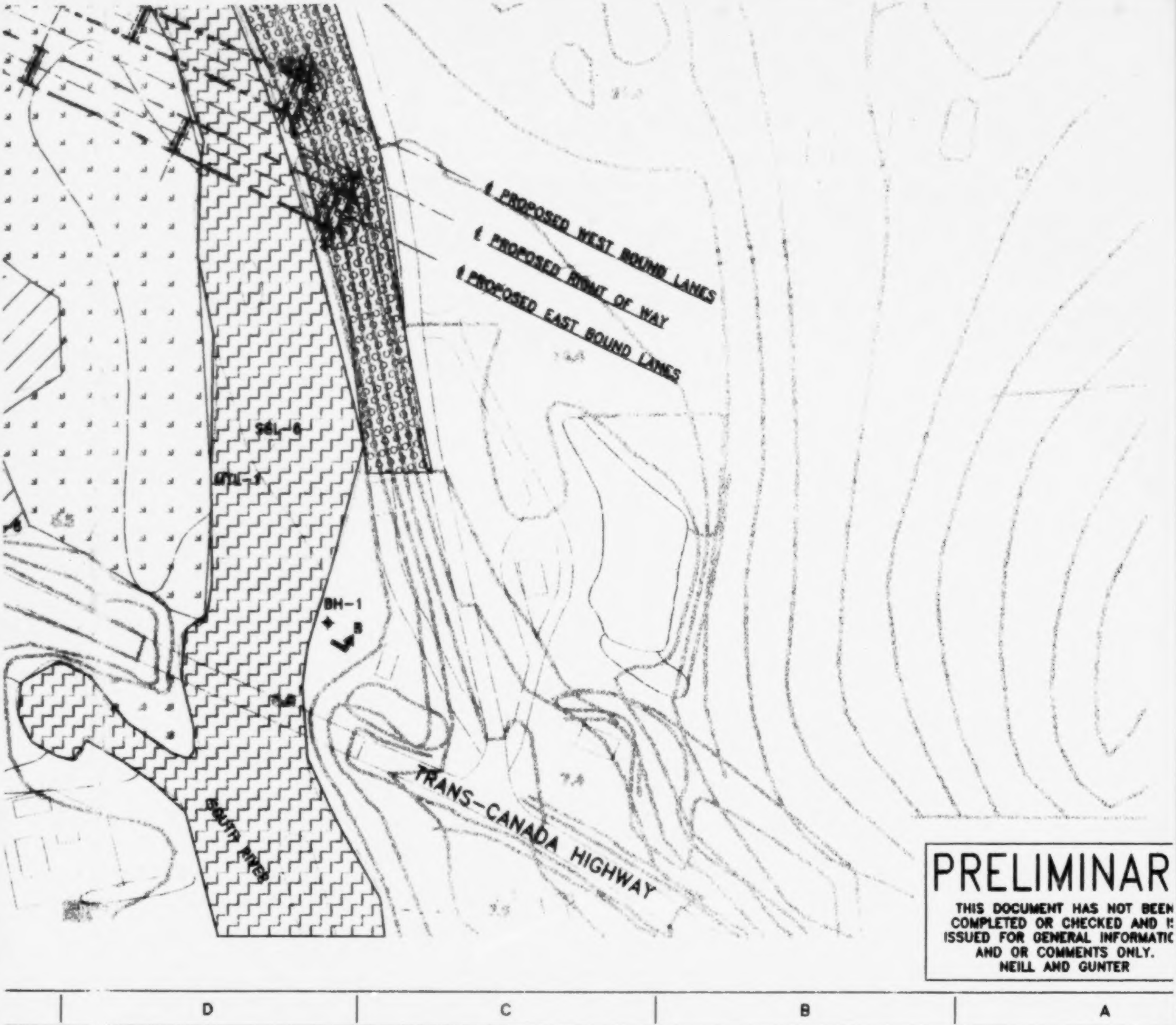

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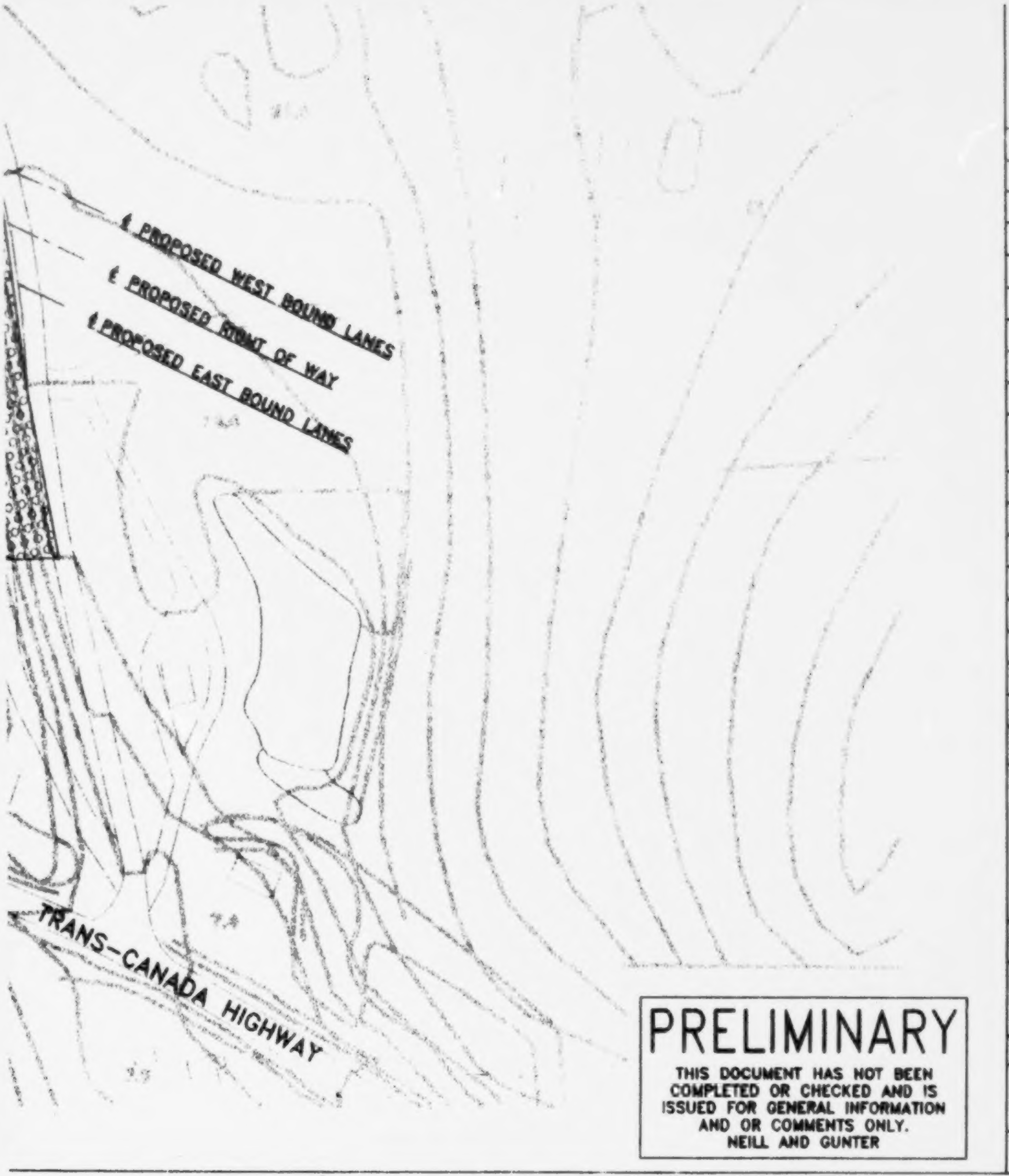

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P.A.L. P.T.

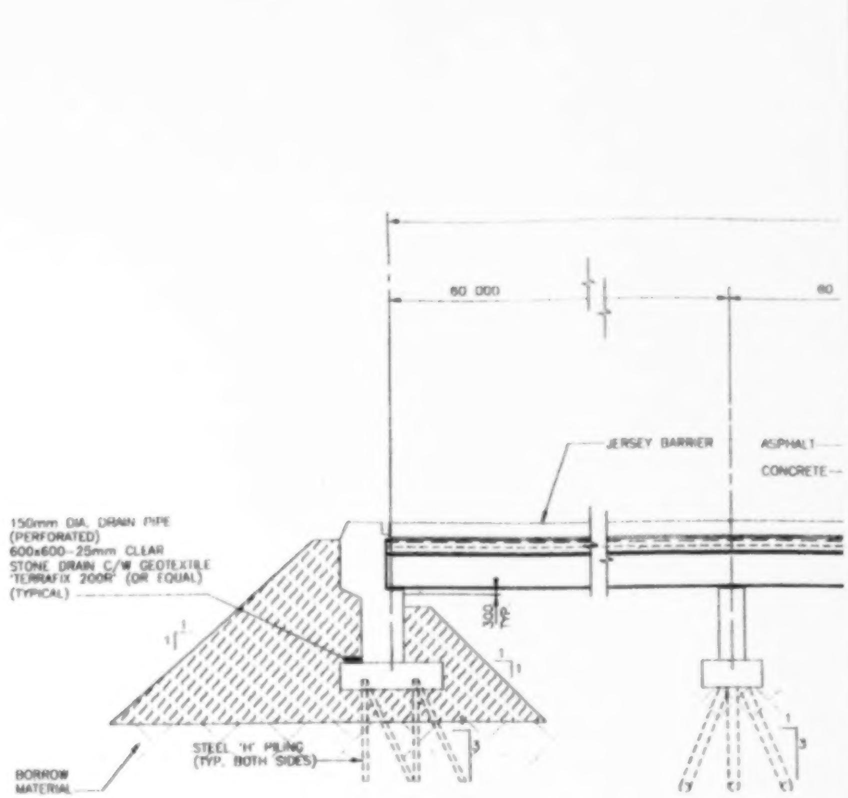
Neill and Gunter
DARTMOUTH, N.S., CANADA

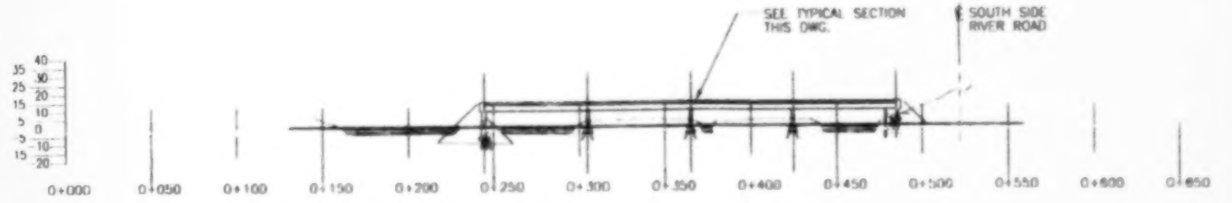
NOVA SCOTIA
Transportation and Public Works
Infrastructure Management Section

HIGHWAY 104 ANTIGONISH SOUTH RIVER IMPACT STUDY

HIGHWAY 104 ANTIGONISH
BIOLOGICAL SAMPLING SITES
AND GENERAL HABITAT TYPES

JOB NO. 16053
DWG. NO. MAP-1
REV. A





℄ PROFILE @ PROPOSED WEST BOUND LANES

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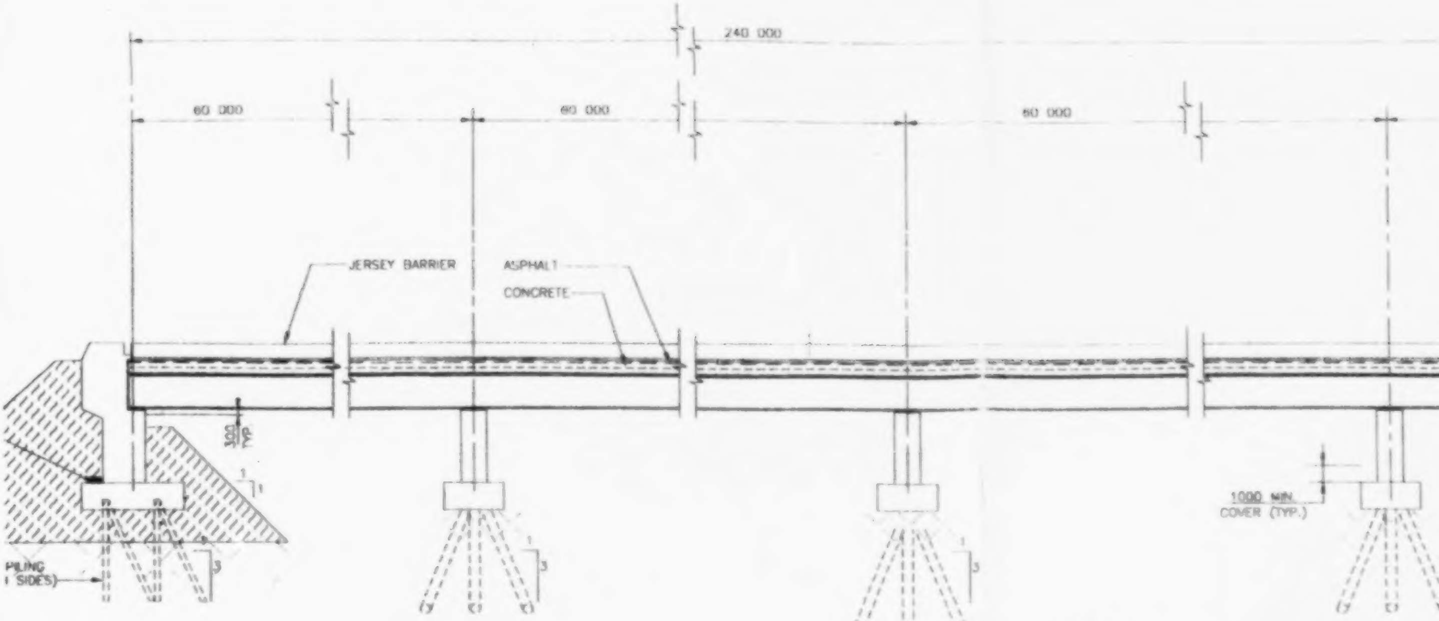
℄ SOUTH SIDE



SECTION B
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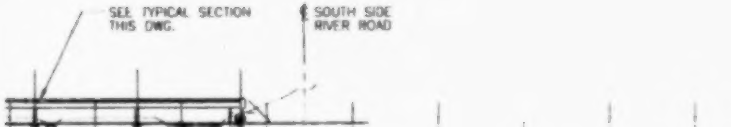
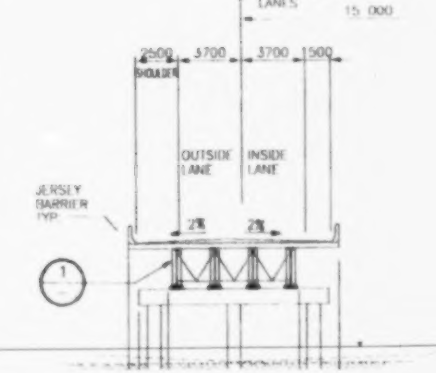
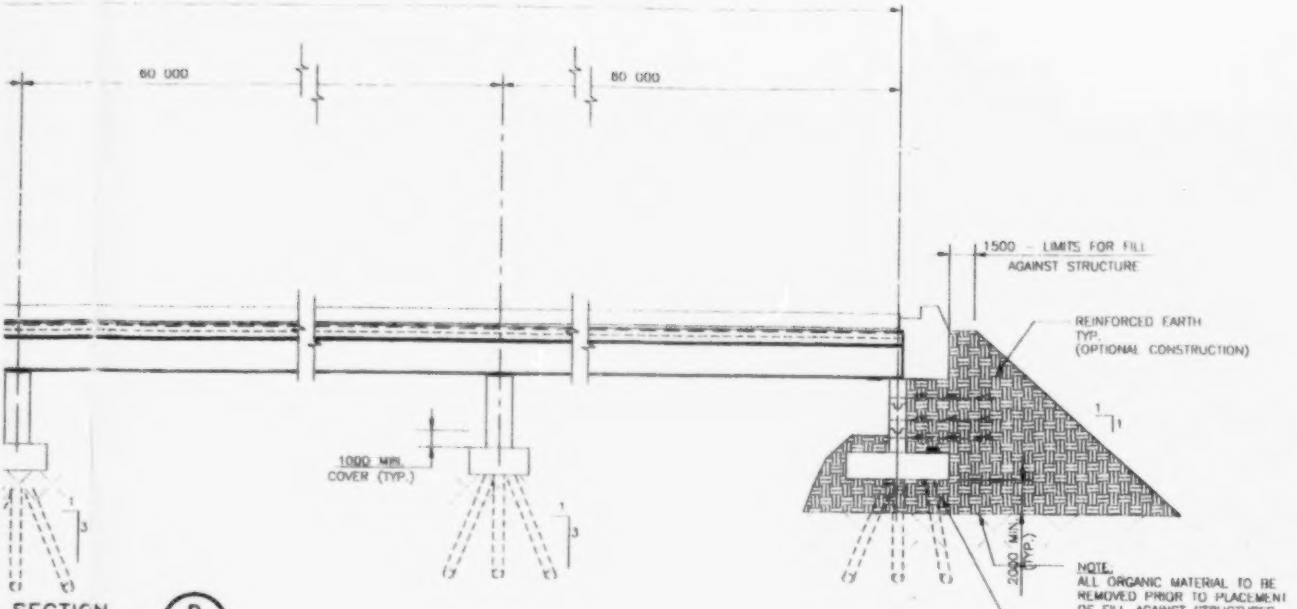
(ELEVATION TO BE SET BY NS DOTC HIGHWAY GEOMETRY)



ROPOSED WEST BOUND LANES
SCALE: 1:4000




80 000
80 000
1500 - LIMITS FOR FILL AGAINST STRUCTURE
REINFORCED EARTH TYP. (OPTIONAL CONSTRUCTION)
1
1
1000 MIN. COVER (TYP.)
1
3
1
3
2000 MIN. (TYP.)

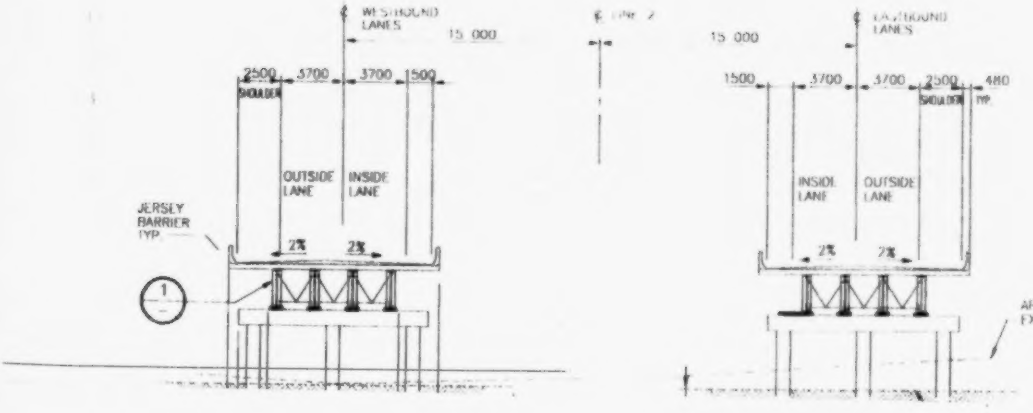
NOTE:
ALL ORGANIC MATERIAL TO BE REMOVED PRIOR TO PLACEMENT OF FILL AGAINST STRUCTURES MATERIAL (TYP.)

FILL AGAINST STRUCTURES MATERIAL (TYP.)

SECTION (B)

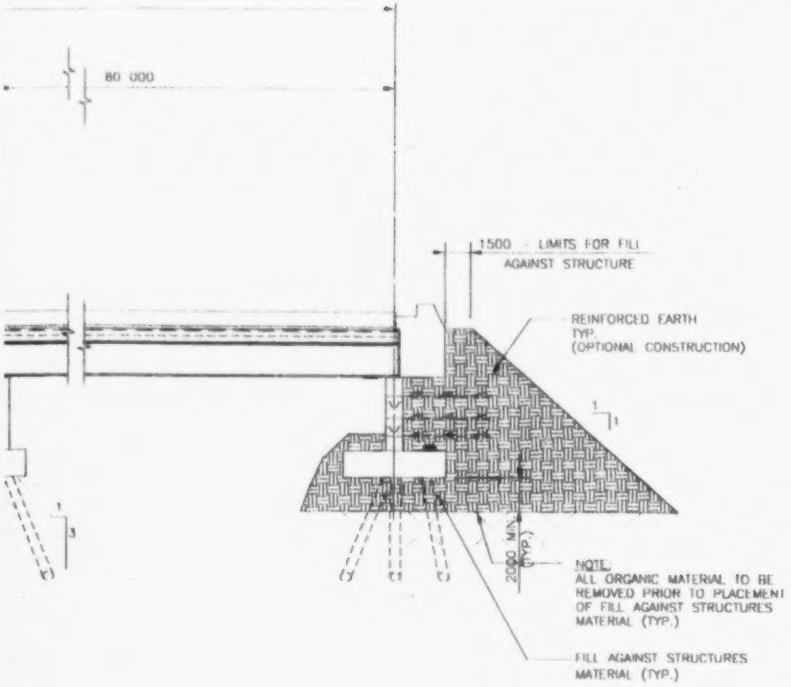
SCALE: 1:400

(ELEVATION TO BE SET BY NS DOTC HIGHWAY GEOMETRY)



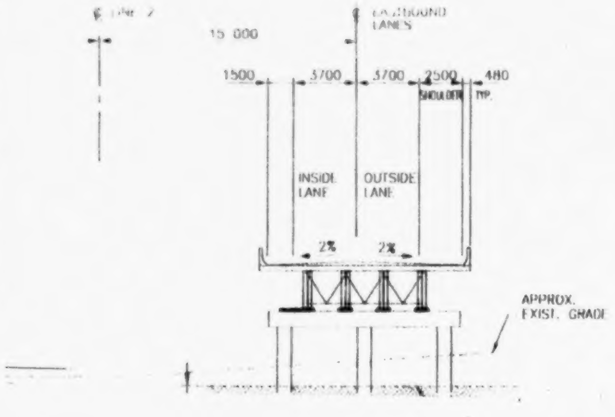
C B A

REFERENCE DRAWINGS		
DWG.NO.	TITLE	BY
1 OF 2	HIGHWAY 104 ANTIGONISH SOUTH RIVER IMPACT STUDY PARTIAL PLAN AND STUDY AREA	NGNS

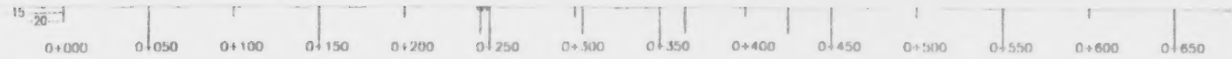


NOTES:

1. FOR GENERAL NOTES AND PARTIAL PLAN SEE DWG. G-301.
2. THIS DRAWING FORMALLY KNOWN AS DWG. 2 OF 2.



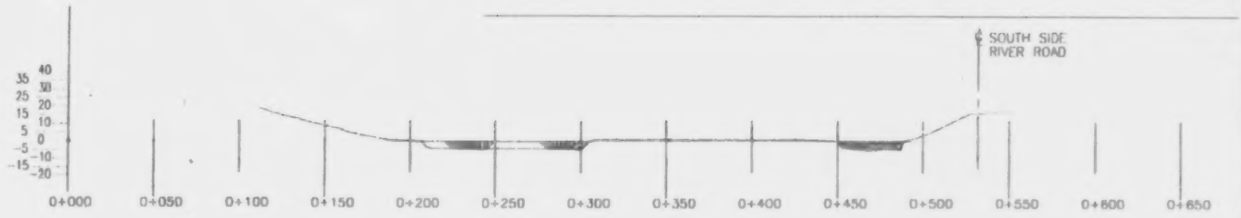
8
7
6
5
4



4

¢ PROFILE @ PROPOSED WEST BOUND LANES

SCALE: 1:4000

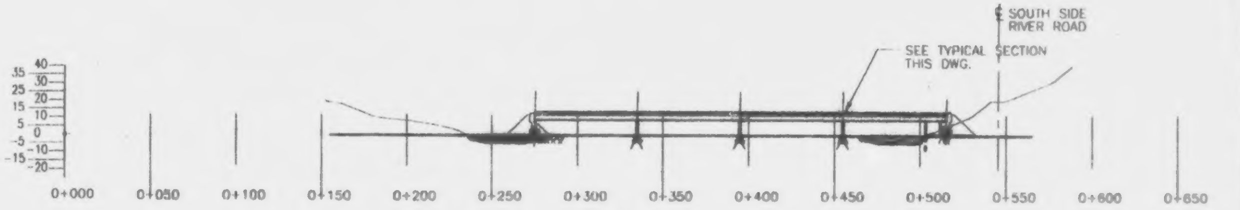


3

¢ PROFILE OF RIGHT OF WAY

SCALE: 1:4000

2

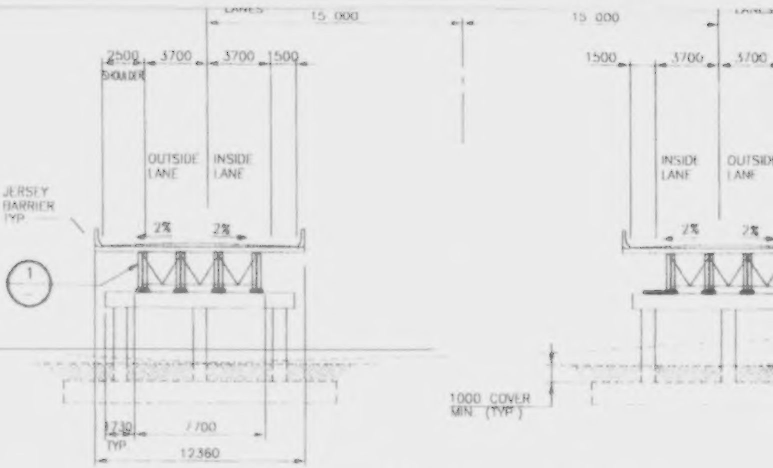


1

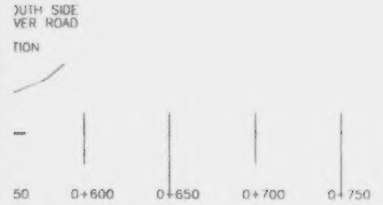
¢ PROFILE @ PROPOSED EAST BOUND LANES

SCALE: 1:4000

J H G F



SECTION A
SCALE: 1:400
C302



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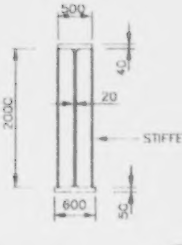
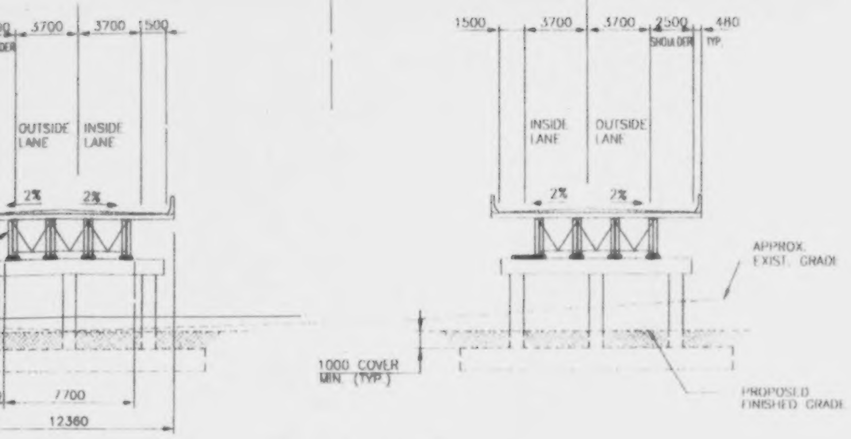


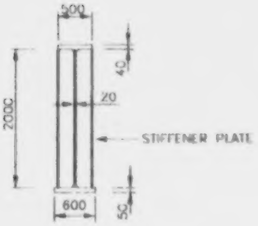
DETAIL
SCALE: 1:100

F E D C



SECTION (A / G302)

SCALE: 1:400



DETAIL (1)

SCALE: 1:100

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HIGHWAY 104 ANTIGONISH

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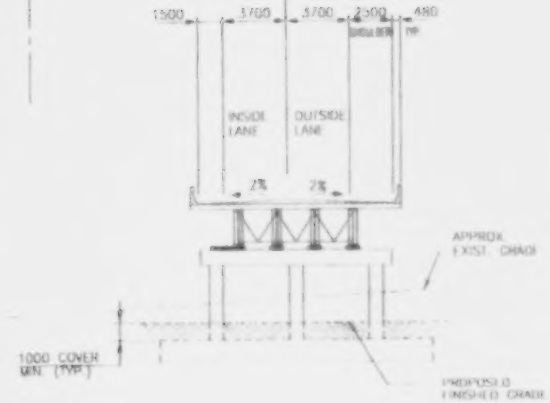
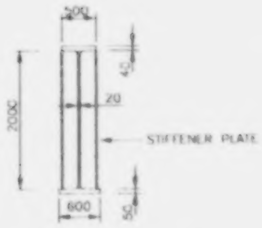
JOB NO. 16053 DWG NO.

C B A



TION 1:400 (A / G302)



DETAIL (1)
SCALE 1:100

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Neill and Gunter
DARTMOUTH, N.S., CANADA

NOVA SCOTIA
Transportation and Public Works

Infrastructure
Management
Section

HIGHWAY 104 ANTIGONISH SOUTH RIVER IMPACT STUDY

CONCEPUAL DESIGN
PROFILES.SECTIONS
AND DETAILS

JOB NO. 16053 DWG. NO. G-302 REV C

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